THE IMPACT OF INTERACTIVE CLASSROOM TELEVISION SYSTEMS ON THE EDUCATIONAL EXPERIENCES OF SEVERELY VISUALLY IMPAIRED STUDENTS

PREPARED FOR THE OFFICE OF EDUCATION, U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

T. K. BIKSON, T. H. BIKSON, S. M. GENENSKY

R-2395-HEW

SEPTEMBER 1979

Rand
SANTA MONICA, CA. 90406

The work upon which this publication is based was performed pursuant to Contract No. 300-75-0123 with the Office of Education, U.S. Department of Health, Education and Welfare.

Library of Congress Cataloging in Publication Data

Bikson, Tora K 1940-
The impact of interactive classroom television systems on the educational experiences of severely visually impaired students.

([Report] - Rand Corporation ; R-2395-HEW)
Bibliography: p.
1. Blind--Education. 2. Visually handicapped children. 3. Teaching--Aids and devices. 4. Television in education. 5. Visual aids. I. Bikson, T. H., joint author. II. Genensky, Samuel M., joint author. III. United States. Dept. of Health, Education, and Welfare. IV, Title. V. Series: Rand Corporation. Rand report ; R-2395-HEW.
AS36.R3 R-2395 [HV1626] 081s [371.9'113] 79-9515
ISBN 0-8330-0142-6

The Rand Publications Series: The Report is the principal publication documenting and transmitting Rand's major research findings and final research results. The Rand Note reports other outputs of sponsored research for general distribution. Publications of The Rand Corporation do not necessarily reflect the opinions or policies of the sponsors of Rand research.

Published by The Rand Corporation

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PREFACE

This report is the most recent in a set of Rand Corporation reports and papers dealing with the problems of the partially sighted, particularly of partially sighted children. Rand's research in severe visual impairment dates back to 1966-1967 with the design, fabrication, and testing of closed circuit TV systems for the partially sighted (see Bibliography). The success of that research led members of the staff to design, construct, and evaluate two multicamera-multimonitor closed circuit TV systems known as interactive classroom TV systems, or ICTSs. These systems permit partially sighted students to be in continuous visual and audio communication with their teachers and with one another in ways that closely approximate the visual-auditory environment of their fully sighted peers.

Rand has also conducted research on the value of binoculars to the partially sighted and on the measurement of visual acuity in the pathological eye. In conjunction with the Center for the Partially Sighted of the Santa Monica Hospital Medical Center, Rand has examined the visual environmental adaptation problems of partially sighted adults. More generally, members of the Rand staff have investigated the service mix provided nationally to handicapped children, including those with limited eyesight.

The research described in this report was sponsored by the Bureau of Education for the Handicapped, Office of Education, U.S. Department of Health, Education, and Welfare through a contract with The Rand Corporation, No. OE-300-75-0123. The report should prove of value to educators of the visually handicapped and their administrators as well as to persons involved in making and carrying out educational policies concerning visually handicapped children. It should be understood that the definition of the partially sighted used here encompasses three-quarters of the legally blind population as well as persons who, although not legally blind, cannot read ordinary newspaper column type even with the help of conventional eyeglasses.

SUMMARY

An Interactive Classroom Television System (ICTS) is a way of creating a visual classroom environment for partially sighted students by using the magnification, brightness, and contrast capabilities of television cameras and monitors. More precisely, an ICTS is a multicamera, multimonitor closed-circuit TV system with videotaping and videoreplay capacity. Such a system permits teachers and their partially sighted students to be in continuous two-way visual communication with one another. Moreover, it allows partially sighted students to function visually in classroom situations similar to those experienced by their fully sighted peers; that is, they can read ordinary printed matter, look at pictures, write with pen or pencil, do workbook problems, consult the blackboard, and draw or paint. Thus, the use of an ICTS both helps prepare students for eventual matriculation into classrooms for the fully sighted and provides an appropriate visual aid that enables students to make the fullest possible use of their residual vision.

The Rand Corporation has carried on ICTS research since 1973. During this time, with funding provided by the Rehabilitation Services Administration (RSA Grant 14-P55846/9) and the Bureau of Education for the Handicapped (OE Contract 300-75-0123), under the direction of Dr. Samuel M. Genensky, Rand has designed and constructed two ICTSs and placed and evaluated them in two different classrooms for the visually handicapped in Los Angeles County. This report describes our BEH-sponsored evaluation of the educational effect of these ICTSs upon partially sighted elementary students.

Overall, our three-year assessment of project outcomes shows that an ICTS can have a strong positive impact on the educational experience of partially sighted elementary school students; about 14 subjects participated in the project annually. With respect to *academic achievement*, examination of standardized test scores showed significant improvement in both reading and mathematics during all three project years. In the first year, students showed more dramatic improvement in mathematics than in reading;

in the second year, reading scores increased markedly, so that no substantial differences remained between the two achievement areas; and by the end of the third year, students had made such substantive gains in both areas that they were performing at grade-normal levels, even though they had begun the project with scores far below grade norms. Finding that long-term exposure to an ICTS can close the achievement gap between partially and fully sighted students is particularly remarkable because without ICTS intervention the gap would be expected to widen rather than narrow with each year of education. Both longitudinal and within-year results indicated that early ICTS intervention is probably most effective in preventing academic deficits related to visual impairment.

In the area of *achievement-related visual skills*, results were positive but less dramatic. Students made strong progress in visual motor integration, but were unable fully to close the gap between obtained and developmentally expected scores; furthermore, older students began and remained a greater distance behind norms than did younger students. Only the second participation year produced substantial gains in visual sequential memory, and these gains were found primarily among the younger students; once again, the importance of early ICTS intervention is shown by these results. However, the very fact that older students' discrepancy from age norms did not increase is encouraging, since this discrepancy had grown yearly before ICTS experience. Because of the stunning gains found in the area of academic achievement, it appears that although some level of perceptual motor skill is needed for reading and mathematics, age-normal functioning is actually not necessary to grade-normal achievement.

Our *psychosocial assessments* showed some positive change in the areas of self-esteem, peer affiliation, and peer attachment. Older students scored higher and showed more improvement over time than did younger students in both self-oriented attitudes and school-related social attitudes. This finding suggests that special attention should be given to the socioemotional climate for lower-grade handicapped

students. In the area of affect encoding (producing facial expressions for various emotions), we found that students at the Killian site, where teachers paid particular attention to facial affect in Year Three, improved markedly during that year; these partially sighted students' post-test scores actually exceeded the scores of the fully sighted control group. This result suggests that with proper classroom emphasis, partially sighted students can learn to produce appropriate facial affect and thereby to increase their social competence. Finally, although students' achievement improved remarkably during the project, their attitudes toward tests remained distressingly consistent and negative; the failure experiences accumulated by many of these handicapped students in test situations seem to have created evaluation apprehensions that are difficult to overcome. In general, we believe that psychosocial mediators of school success for the partially sighted deserve further investigation.

Observations of *classroom behavior* intended to supplement information gained by outcome measurement determined that students spent more than half of their time overall using the ICTS, and that nearly all of their classroom time, both on and off the system, was spent in on-TASK behavior. We also found that as students used the ICTS over a long period of time, they tended gradually to become less dependent both on their teachers and on the system, and to spend more of their time working independently on-TASK but off-SYSTEM (i.e., perceiving stimulus materials directly, without the magnification provided by the ICTS).

In summary, the three-year project demonstrates that the ICTS had a strong and stable positive impact on the learning experience of a sample of partially sighted elementary school students. Moreover, classroom observation data indicate an extremely high level of on-TASK performance, along with a sophisticated use of the ICTS as a tool rather than as a crutch. While the participating sample was small and a control group design was not feasible for this research, subjects were not atypical in a manner that appeared to interact with project results. Moreover, access to visual information is known to enhance learning. We thus believe that, given the evaluation results, the ICTS appears

to be sufficiently successful to justify its dissemination to other selected school districts. Most metropolitan areas with a population of at least 50,000 would, we believe, have enough partially sighted school children to warrant the installation of such equipment. In this way, a large proportion of the severely visually impaired might have the opportunity to develop the capability for leading full educational, vocational, and social lives.

ACKNOWLEDGMENTS

The authors thank their colleagues Janice Banks, Raymond W. Clewett, Arthur Lucero, Angelo Makris, Dr. Harold F. Petersen, Stephen G. Strand, Michael E. P. Wallters, Don Williams, and Roy Yoshimura for the part they played in the design fabrication, installation, and maintenance of the two interactive classroom television systems used in this study. These people firmly believed that they were participating in an important effort to help visually impaired children, and this belief helped them sustain a level of industry and enthusiasm that permitted them to create and maintain equipment of the highest quality and reliability.

Our gratitude is extended to the following members or former members of the staff of the Rowland Unified School District: Dr. Stanley G. Oswalt, Superintendent; Dr. Clinton E. Boutwell, Assistant Superintendent, Educational Production Division; William D. Hatcher, Director of Special Education; Tully R. Valmossoi, Principal, Killian Elementary School; LaVerna Fredregill, Program Specialist, Visually Handicapped Program; Sandra L. Bridges, Special Education Psychologist; Lavonne Kelly and Rikk Morris, teachers of the visually handicapped; and Kathleen Lane, Della Sewell, and Sue Stone, teaching assistants.

Sincere appreciation is also expressed to the following members of the Santa Monica Unified School District: Dr. George L. Caldwell, Superintendent; Dr. Anthony Baratta, Assistant Superintendent, Education; Dr. Frank D. Taylor, Supervisor, Special Education Program Development; Dr. Robert J. Stillwell, Supervisor, Special Education Services; Arthur C. Bystrom, Principal, Madison Elementary School; Dr. O. Arthur Rosenthal, Psychologist; Jadeane B. von der Lieth, teacher of the visually handicapped; and Pam Harris and Judy Wolf, teaching assistants. These people gave us their full cooperation to ensure that the ICTS intervention and evaluation proceeded smoothly and efficiently. Special thanks are given to the teachers who participated in this research. Early in the project they recognized that an ICTS might have great potential for their students, and hence they did all they could to explore its various aspects, while continuing to give freely of their attention and consideration to those students.

In addition, we wholeheartedly thank the participating students. These children never disappointed their teachers or us. Their enthusiasm, industry, and cooperation inspired us all, and helped sustain our own enthusiasm and dedication to this research effort.

Dr. Jacqueline Goodchilds and Dr. Gene Fisher gave a careful reading of the manuscript of this report; their comments and suggestions led to a significant improvement in the final product. We also acknowledge the extensive work done by Alice Bloch to pull together the many diverse elements that went into the initial draft of this report. Finally, we thank Edith Kuhner for coordinating the typing of the numerous drafts of this report and for her own careful typing.

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I. INTRODUCTION

HISTORY AND PURPOSE OF THE INTERACTIVE CLASSROOM TELEVISION SYSTEM

An Interactive Classroom Television System (ICTS) is a way of creating a visual classroom environment for partially sighted students by using TV's magnification, contrast, and brightness capabilities. More precisely, an ICTS is a multicamera, multimonitor closed circuit TV system with videotaping and videoreplay capacity. Figure 1 shows a 9-camera, 8-monitor system in an elementary school classroom. Such a system permits teachers and their partially sighted students to be in continuous visual communication with one another. Moreover, it allows partially sighted students to function visually in classroom situations closely akin to those experienced by their fully sighted peers; that is, they can read ordinary printed matter, look at pictures, write with pen or pencil, do workbook problems, consult the blackboard, draw or paint. Thus, use of an ICTS makes partially sighted students more aware of what is expected in classrooms for the fully sighted and, equally important, more aware of what they could be missing if they are placed in classrooms without appropriate visual aids. Behind the construction of the ICTS stands the philosophy that every person should have the opportunity to make the fullest possible use of residual vision in order to lead a maximally productive and satisfying life.

In 1973, The Rand Corporation was engaged in research on "Information Transfer Problems of the Partially Sighted," funded by the Rehabilitation Services Administration (RSA Grant 14-P-55846/9), under the direction of Dr. Samuel M. Genensky. Early in that year Genensky sought RSA approval to construct and proof test an interactive classroom television system as part of the research project. Permission was granted by RSA, and Rand designed and constructed the first ICTS over the nine-month period March to November 1973. That ICTS was installed in a small classroom primarily for partially sighted children in the Madison Elementary School in Santa Monica, California (Site I), in late November 1973 (see Fig. 1.2); it has been in continuous operation in that setting.

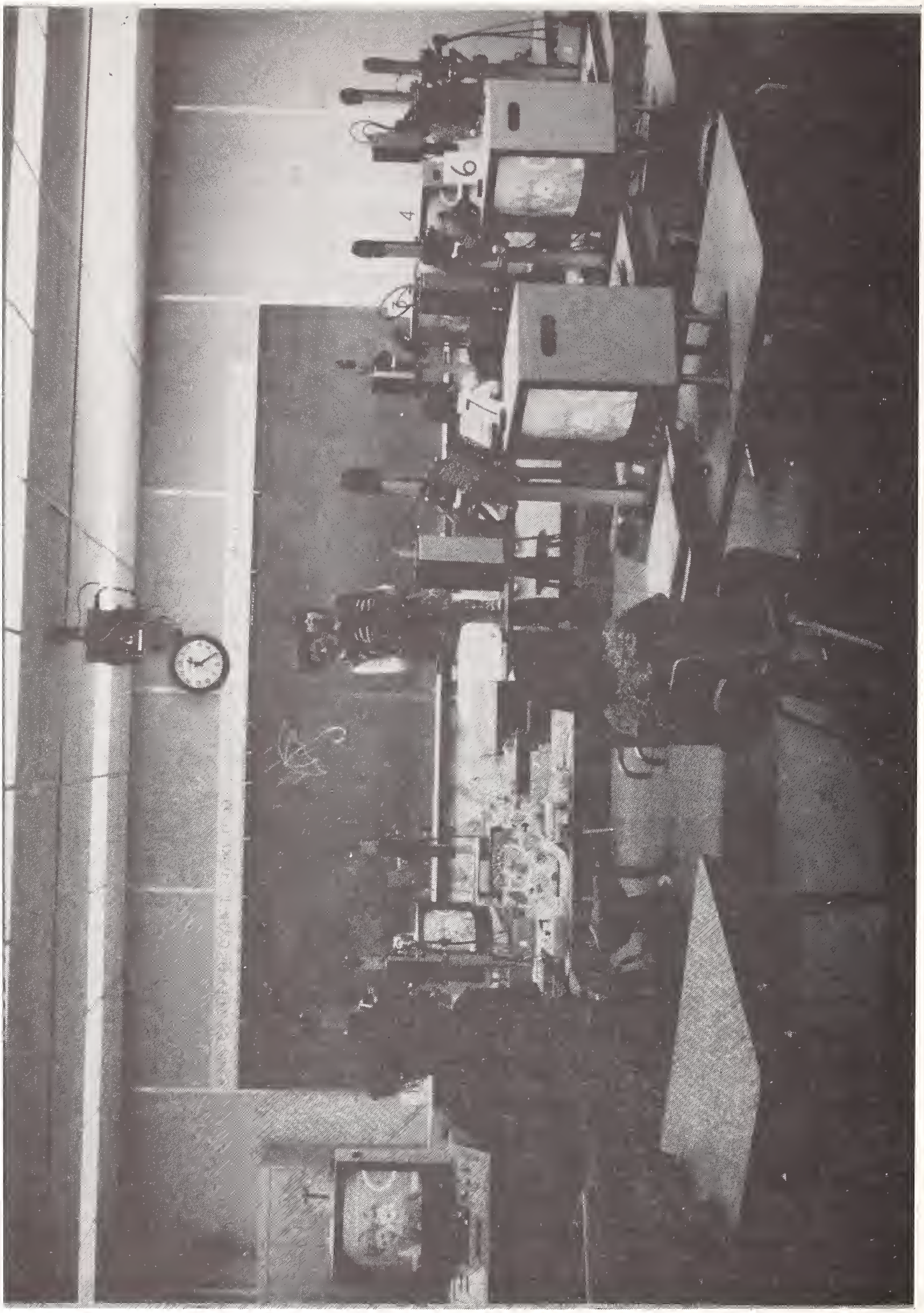

Fig. 1.1—Killian site 8-station ICTS

Fig. 1.2—Madison site 4-station ICTS

The ICTS was a technical success. However, systematic study of its educational implications had not been a part of the RSA-sponsored research. Consequently, in 1974 Genensky approached the Bureau of Education for the Handicapped (BEH) of the Office of Education to ascertain whether that Bureau would support a research project to determine how an ICTS helps in teaching basic skills to partially sighted elementary school children in classroom settings. BEH expressed interest in such a project, and in February 1975, a contract was signed by The Rand Corporation and by the Office of Education (Contract 300-75-0123). That contract called for the design and construction of a second-generation ICTS to be installed in an elementary school classroom for partially sighted children; it also required an evaluation of the effect of that system as well as the first-generation system on the learning experiences of partially sighted students. The second-generation ICTS was completed in November 1975 and was immediately installed in the Killian Elementary School (Site II) in Rowland Heights, California (Fig. 1.1), where it has remained in continuous operation. Evaluation data presented in this report represent approximately three academic years: 1975-1976 (although students at the first-generation site had already had some ICTS experience); 1976-1977; and 1977-1978, the final year.

HOW THE SYSTEM WORKS

As we have said, an ICTS is a multicamera, multimonitor closed circuit black and white TV system. The system consists primarily of N stations,* control console, a ceiling-mounted room-viewing camera, and a videotape recorder. Figure 1.3 shows a single station with the following features: a down-pointing TV camera equipped with a 5-to-1 zoom lens, which in turn has close-up capability; a TV monitor mounted at eye level; a light source for illuminating reading and writing materials; and an X-Y Platform, a movable work surface that has margin stops in

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*A system could have any number of stations, depending on the number of students. Our first-generation system has four stations, while the second-generation system has eight.

Fig. 1.3—An ICTS student station

the "X" or left-right direction and friction control in the "Y" or line-to-line direction. The X-Y Platform supports reading and writing materials below the down-pointing camera. In an ICTS classroom, N-1 of the stations are for use by students and the Nth station normally is for use by the teacher(s); however, it is not unusual to see the teacher's station in use by a student.

The control console for the classroom system is typically located at or near a teacher's desk. Both the first- and second-generation systems have control consoles which permit teachers to present on any one of the system's station monitors, independently of what is presented on any other monitor: (1) a full-screen image of the output from any one of the system's cameras or from its videotape recorder; (2) a horizontally split image of the output from any two of these sources;

or (3) a full-screen superposition of the output from any two of these sources. With these system capabilities, for instance, partially sighted students can work individually on their own materials or all read what is displayed from the teacher's desk; they can write solutions to arithmetic problems displayed on the board without having to recopy the problems themselves; and they can fill in the blanks on a superimposed workbook page. In addition, the newer control console permits the teachers to present the same simple or composite image on all station monitors at one time by a special set of simple commands, or to allow each station's monitor to display a full-screen image of the output from its own station camera by another set of simple commands.

The system's room-viewing camera is mounted on the ceiling of the classroom and is run remotely. It can pan and tilt, and hence can bring virtually any part of the classroom within the view of its 10-to-1 zoom lens. This enables students to look, for example, at the clock, at the calendar, at the blackboard, or at their teachers and classmates. Like all other cameras of an ICTS, the room-viewing camera can present both positive and negative images of what it sees.

Last, the videotape recorder permits teachers to record information displayed on any of the system's station monitors, and to record lessons prepared by one or more teachers with the help of one or more of the system's cameras. These materials can then be shown to one or more students, or can be shown and reviewed by one or more of the teachers. Moreover, the videotape recorder can record off-the-air programs in black and white or in color; these videotaped programs can then be shown on a black and white or color TV receiver in the classroom that, in turn, can be viewed by one or several students at one time. The number of students who can participate in this activity at one time depends upon their level of vision. A more detailed description of the first- and second-generation ICTS is available in two earlier reports published by The Rand Corporation (Genensky et al., 1974; Genensky et al., 1977).

CLASSROOM CLIMATE

Even a casual glance at Figs. 1.1 and 1.2 suggests an environment quite different from a regular classroom and from a resource room for the visually handicapped, even though the latter may well include an individualized closed circuit TV. A brief look at the social-psychological climate during ICTS implementation and post-implementation periods will help to provide a context for the more technical assessments of students' learning experiences that follow.

In describing the actual implementation process, it is difficult to avoid hyperbolic expressions. On the one hand, the intervention itself was extremely disruptive; the classrooms underwent a major transformation in terms of both their physical appearance and the daily routine. Moreover, because of the magnitude of the intervention and its experimental nature, the ICTS project drew a steady flow of visitors, turning the classrooms into veritable fishbowls. On the other hand, students and teachers seemed to accommodate these changes without distress; in fact, they seemed very positively motivated toward the project, a condition that undoubtedly contributed in no small way to its success. Informal impressions of the research staff--most notably those of the researcher who performed systematic observations in both sites from the beginning of the evaluation effort--suggest that regarding the ICTS as a promising learning opportunity accounted at least in part for the participants' adaptation to such major changes.

More than 65 percent of the participating students were legally blind, and about half had multiple handicaps; some of the subjects were extremely bright, while others had severe learning disabilities. And all were aware, well before the ICTS intervention, of being in a "special" classroom and of differing both socially and academically from regular fully sighted students. Classroom observations began in both sites in fall 1975, three months prior to the installation of the second-generation ICTS in Site II.* During those months an air of

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*Installation of the ICTS in the second site had been recommended for summer 1975, so that by the time students arrived the system would

anticipation prevailed; work was performed in a more-or-less perfunctory manner as students and teachers awaited the arrival of the system. Actual installation brought chaos and confusion, with workmen unpacking components and assembling units while teachers rearranged furniture; normal classroom activity was suspended. It is difficult to know the extent to which the students understood what was going on. They knew that something unique was happening, that it involved television, and that through the use of television they would be able to "see" things they had not been able to see very well, if at all, before. Rather than becoming bewildered, disgruntled, demanding or withdrawn, the students faced this prospect with curiosity and delight.

Between the time of installation (about Thanksgiving) and Christmas recess, most students had learned to adjust their cameras and monitors to meet their individual visual needs for reading and writing or printing. The reward for such accomplishments was visual access to the entire classroom and its inhabitants; it was as if the students had acquired a "new" sense. They could see their work, they could see the faces of their classmates and teachers, they could see the chalkboard and bulletin board, they could see a variety of curricular materials--they could even see themselves. In short, for the first time the entire physical and social classroom environment was brought within the range of their residual visual capabilities, and seeing was becoming a major source of information at school. Students seemed to be pleased with the system and their own mastery of it; they proudly demonstrated their skill in its use to regular students, to parents, and to the continuing flow of classroom visitors.

In contrast to the second-generation site, the first-generation site had undergone implementation the year before. Consequently, when school opened and our observations began in the fall, the ICTS was already fully assimilated into the classroom activity pattern there. The students were quite adept in all phases of ICTS operation, including the operation of the teacher's master control unit. Rather than being the focus of attention, the ICTS was taken for granted as

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be fully in place and the teachers would have had an opportunity to become familiar with it. Delays in funding and subsequent delays in delivery of system components necessitated a later installation date.

a tool, a low-vision aid. And, while visitors still came to the classroom, they were not a matter of special notice. We saw changes in this direction occurring at the newer site throughout the school year so that, although the two classrooms remained quite different in curricular organization and behavior style, by the beginning of the second academic year the ICTS had become fully incorporated into the regular routines of both. A three-year evaluation was carried out to document as systematically as possible the effects of the ICTS on the learning experiences of participating students.

Monitors used at both sites were tested by an independent radiological measurement firm to determine whether they presented any X-ray hazard to persons viewing them for long periods of time with their eyes in very close proximity to the face plates of the TV monitors. As previously reported (Genensky et al., June 1975; Genensky et al., June 1977), results of testing the equipment at both sites found no X-ray hazards present to persons using the ICTS even under the conditions specified above. A second safety consideration concerned the placement of cables so that they did not interfere with walking about the classroom. At the Madison site the stations were arranged in a square. The central control box was located at the center of the square enclosed by the tables on which the individual stations were positioned; all cables originated from the control box to the rear of the ICTS equipment, safely out of the way of any foot traffic. At the Killian site, all cables were placed underneath the floor of the classroom, emerging under the tables supporting the ICTS equipment. Moreover, all cabling in the systems carries only low voltage (6 volts) for control purposes, and video signals are 1 volt or less. All 115-volt power lines are connected to separate grounded enclosures, and all power distribution was carried by three-wire grounding-type connectors. A heat shield was designed for the station lights which allowed the user to adjust the direction of the light source without discomfort. Each monitor is equipped with an integrally bonded heavy glass implosion shield. Finally, even the X-Y Platforms were modified to lessen as much as possible the danger of minor injuries, such as a pinched finger.

ORGANIZATION OF THE REPORT

This report describes our evaluation of the educational effects of the ICTS on partially sighted elementary school students at the two project sites. Section II discusses the research design for the evaluation: the outcome areas examined, the kinds of assessments made, the design issues encountered, the characteristics of the sites and the subjects, and the data collection schedule. Sections III through V present our results for each of the three project years and our longitudinal results, in each of the outcome areas examined: academic achievement, achievement-related visual skills, and psychosocial assessments, respectively. Results of observation of classroom behavior are discussed in Sec. VI. Finally, Sec. VII draws general conclusions and discusses implications for educational practice, policy, and future research. In the main, our evaluation suggests that the ICTS has had strong and stable positive effects on the learning experiences of partially sighted elementary students in Sites I and II, and we recommend that it be disseminated to other school districts.

II. RESEARCH DESIGN

The fundamental goal of the Interactive Classroom Television System (ICTS) is to improve the educational experiences of partially sighted elementary school students. A plan for achieving this goal has been implemented in two different classroom sites: the first-generation system is housed in a classroom serving primarily partially sighted children, with a maximum of six students; the second-generation system resides in a self-contained classroom for the visually handicapped and serves a maximum of 14 students. Because the project was multifaceted, assessment of the extent to which it met its objectives required collection of varied sorts of data tapping distinct areas of effect. Where appropriate, the data were treated statistically to determine significance of outcomes. Where such treatment was not appropriate, project data nevertheless constituted rigorous documentation of procedures and results, appraisable on a case study basis. Both sorts of information are regarded as useful contributions to evaluation, where the purpose of evaluation is assumed to be the systematic reduction of uncertainty about program effects.

For convenience, program effects for students were conceptualized in terms of four areas. Of primary importance was the impact of the ICTS on *academic achievement* in basic elementary school skills. Basic skills, for the purpose of this evaluation, were restricted to verbal and quantitative proficiency as measured by standardized achievement tests. A second area of concern was the relationship of the ICTS to *visually dependent perceptual-motor processes* such as visual-motor integration and visual memory. For the partially sighted student making use of residual vision by means of an ICTS, these processes are important mediators of information encoding and decoding and thus could have a substantial influence on learning. Next, the project examined what effect, if any, the ICTS had on *self and social attitudes* (for instance, self-esteem and school affiliation) thought to be significant in students' school experiences. The final assessment domain, *classroom*

behavior, sought to determine, through observation, the extent and organization of task-relevant activity when students made use of the ICTS.

DESIGN ISSUES

The overall evaluation design for the ICTS project is properly regarded as a "one-group pre-test post-test design" (Campbell and Stanley, 1963). Such a design, as it represents the current assessment, can be systematized as follows (where X stands for the treatment, 0 stands for observations, and subscripts represent occasions of observation):

$$0_{pre} \underset{0_1\ 0_2\ 0_3\ 0_4\ 0_5\ 0_6\ 0_7\ 0_8\ 0_9}{\overline{\qquad\qquad X \qquad\qquad}} 0_{post}$$

The schema indicates that pre- and post-measures were obtained and supplemented by other observations collected repeatedly throughout each school year in which the ICTS was in operation. While this evaluation design has many features of "quasi-experimental" methods such as time-series experiments and recurrent institutional cycle designs (Campbell and Stanley, 1963), it is probably best classified as "pre-experimental." Because the use of a pre-experimental design raises serious methodological issues, these issues have been examined in some detail.

What renders the design pre-experimental rather than experimental is that it is a one-group study; an experimental version of the same study would employ two groups, the treatment group and a nontreatment comparison group. The description of the subject population for the present study, however, should indicate why the use of a comparison group design was not feasible. Briefly, comparison subjects could not be selected randomly but would have to be chosen by matching along numerous dimensions (chronological age, IQ, visual acuity, other handicaps, and verbal and quantitative achievement levels) which do not naturally covary. If appropriately matched subjects could be located, their very uniqueness would render their usefulness as comparison subjects questionable. Further, use of such subjects would not provide

a no-treatment comparison condition. Rather, these subjects would be drawn from the special education programs of various other schools; thus they would be recipients of unspecified and diverse treatments involving different teachers, different curricular contents, and different time-management plans. Consequently, any outcome comparisons between ICTS students and the matched group would be problematic to interpret. A comparison group, then, would not have contributed substantial information to this evaluation; it would have made the evaluation experimental in name only.

Having looked at the reasons for choosing a one-group design, we then considered and weighed the potential threats to validity it involves. As noted in Campbell and Stanley (1963), there are two classes of threats to validity in a one-group as opposed to a two-group design: history-maturation confounds and testing-instrumentation confounds. This project minimized threats to internal validity by excluding other sources of academic innovation in those classroom sites, and by attempting to ensure that the history of the ICTS classroom was in no other respects atypical. However, visual impairment of subjects is regarded as posing a natural impediment to academic skills maturation, so maturation was not a plausible rival hypothesis for explaining gains made with the ICTS in the present study (cf. Kakalik et al., 1973). Both test reactivity and instrument decay, we think, were even less likely sources of systematic variation in outcomes, given students' extensive preproject experience with test-taking and our own efforts to hold circumstances of administration constant across occasions of testing.

Finally, while regression artifacts often threaten internal validity for either a one- or a two-group design in a field intervention, they did not arise as an alternative explanation here for two reasons. First, the study did not rely on mean scores for subjects as a group, since the subjects performed at quite different age and ability levels. Second, individual scores could not be compared with *appropriate* population means, since the latter have not been determined. Subjects' achievement scores were expected to change in the direction of grade norms. Such changes could not, however, be interpreted

primarily as statistical regression toward a true population mean, since initial depressed scores did not represent the extreme ends of a sampled normal distribution (therefore involving a greater proportion of sampling error), but rather the typical performance of a population of nonnormal subjects. Thus evaluation of subjects focused on within-subject changes from one occasion of observation to the next, with consistent changes in the direction of grade-normal performance throughout the intervention being interpretable as performance gains rather than statistical artifacts.

With the general evaluation design so understood, data collection efforts reflected the schedule and subject distribution presented in Table 2.1. Table 2.2 gives subjects' age, sex, ethnicity, and socioeconomic status, along with information about the duration of their participation in the study.

Table 2.1

DATA COLLECTION SCHEDULE[a]

	Site I		Site II		Total N at Post Test	New Subjects	Continuing Subjects
	Pre	Post	Pre	Post			
Year 1 (1975-76)	5	5	8	8	13	13	0
Year 2 (1976-77)	3	3	11	11	14	5	9
Year 3 (1977-78)	3	3	11	11	14	3	11

[a]Some students remained in the project for all three years; for others only one or two years of evaluation data were available. The last two columns in this table indicate the total number of newly entering and continuing subjects during each project year.

Table 2.2

SUBJECT DEMOGRAPHICS

				Project Year:	I		II		III	
Subject	Date of Birth	Sex	Ethnicity	SES Estimate	Nominal Grade Level	Age[a] 10/75	Nominal Grade Level	Age[a] 10/76	Nominal Grade Level	Age[a] 10/77
Site I										
101	10-4-64	F	Black	3	6	132				
102	2-21-65	M	Black	1	5	128	6	140		
103	3-4-67	M	White	4	3	103	4	115	5	127
104	7-24-66	M	White	4	4	111	5	123	6	135
105	9-9-69	M	White	3	1	73				
106[b]	1-29-71	M	White	3			PreK	...		
107	4-23-72	M	Black	3					K	66
Site II										
201	11-20-67	F	Black	3	3	95	4	107	5	119
202[b]	7-2-66	F	White	3	4	...				
203	1-4-64	F	White	1	6	141	6[c]	153		
204	7-27-69	M	Chicano	2	K	75	1	87	2	99
205	10-6-69	M	White	2	1	72				
206	4-7-70	M	Chicano	2	K	66				
207	12-12-70	M	Chicano	2	PreK	58	K	70	1	82
208	9-4-70	M	Black	3	K	61	1	73	2	85
209[b]	12-10-67	F	Black	3	3	...				
210	8-13-64	M	White	2	6	134	6[c]	146	6[c]	158
211	3-6-70	M	Chicano	1	1		1	79		
212	7-17-70	M	Black	3			K	75	1	87
213	7-5-67	F	Chicano	1			4	111	5	123
214	2-9-69	M	White	1			2	92		
215	9-24-65	M	Black	3			6	133	6[c]	145
216	6-8-68	F	Chicano	2					4	112
217	7-19-68	F	Chicano	3					4	111

[a]Ages are listed in months only.

[b]Subjects were accepted into the study, but either moved or were transferred before one full year of data could be collected.

[c]Subjects had achieved neither academic nor social maturity for matriculation.

SITE CHARACTERISTICS

The two ICTS classroom sites differ quite markedly with respect to physical setting, student population, and organization. The Madison site (housing the first-generation system) consists of an 18-by-32 foot room with four ICTS stations, including the teacher's station. The equipment occupies approximately 50 percent of the room; the rest of the room contains student centers, with storage shelves along the perimeter and a carpeted open area in the center.

Over the three years of the study (1975-1976, 1976-1977, and 1977-1978), subjects at the Madison site numbered five, three, and three, respectively. At the end of the first year, one subject matriculated and another moved away from the school district; between the second and the third years, one subject matriculated and one entered the class. The age of the subjects ranged from six to twelve years, and the nominal grade distribution (i.e., grade in which students were officially enrolled, not always commensurate with age or ability) included first, third, fourth, fifth, and sixth. In addition to ICTS subjects, the classroom regularly served one to three other handicapped students. Moreover, the population of the classroom varied considerably because students from an adjoining resource room used the classroom during part of the day.

There was one regular teacher in the classroom; she participated in the ICTS study from its beginning. In addition, the class had one regular aide, a mobility instructor for the functionally blind who made daily visits, and a physical education instructor who visited weekly. Finally, several adult tutors gave varying amounts of time to the class during the school year. Overall, the average adult-student ratio was about one to three.

This ICTS classroom was open from 8:45 to 11:30 for basic skill instruction. At 11:30 the students went to lunch, after which the partially sighted subjects attended regular classroom appropriate to their grade level for such activities as music and art.

The Killian site (where the second-generation system is located) involved a 32-by-64 foot room with eight stations, including the teacher's. Although the classroom was much larger, the equipment

occupied about 50 percent of the available space, as it did at the Madison site. The Killian classroom was fully carpeted, with the non-ICTS area used for student centers and storage shelves.

During the first year of the project, eight Killian students particpated in the ICTS study. During the second year this number grew to eleven, with six returning subjects and five new ones. In the third year, eight returning subjects and two new ones made a total of ten. The age of the subjects ranged from four to thirteen years, and nominal grade levels ranged from prekindergarten to sixth. As in the Madison classroom, this site also typically served non-ICTS students and accommodated an occasional student from an adjoining resource room.

Two regular teachers have been with this ICTS classroom since its inception. There were two regular aides and several student aides from the nearby junior and senior high schools as well. In addition, a mobility instructor and a speech therapist came to the classroom several times a week. The mean adult-student ratio was approximately one to two.

The Killian classroom was self-contained, providing not only basic skills instruction but also a full range of learning experiences including physical education, art, and music. Subjects in the ICTS classroom did not, therefore, interact with normally sighted students during the regular class day. The classroom opened at 8:30, and students left the room at staggered times. Prekindergarten and kindergarten students were dismissed at noon, grades 1 to 3 left at 1:30, and grades 4 to 6 left at 2:30.

SUBJECT CHARACTERISTICS

All student participants in the ICTS project were partially sighted. For definitional purposes, this means that the visual acuity in their better eye, even with the help of ordinary corrective lenses, did not exceed 20/70* but was better than light perception or light

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*A person with visual acuity in the better eye that does not exceed 20/70 even with ordinary corrective lenses is usually unable to read newspaper column type with or without such lenses.

projection.* Further, although some of the students had multiple handicaps, they were considered eligible for the project only if their nonvisual handicapping conditions would not seriously interfere with their successful use of the ICTS equipment. When students in the schools housing ICTS classrooms met these criteria, and if their parents and their teachers as well as members of the Rand project staff agreed that they would benefit from an opportunity to participate, they were admitted as subjects in the study.

Descriptions of the selected subjects and the years in which they participated in the project are presented in Table 2.2. Participation in a project year is denoted by the listing of a "nominal," or officially enrolled, grade level and chronological age (in months) for each subject. For example, subject 101 is a one-year participant who was enrolled as a sixth grader during Project Year I; subject 204 participated in all three project years and although at Year Three was in the third grade, we note in subsequent chapters that he was not functioning at that level; subject 216 participated in Project Year III only, and so on. The SES estimates are ordinal estimates provided by teachers, based on their contact with parents both at school and at the homes of the subjects. A rank of 1 designates lower status (welfare); 2 is lower middle; 3 is middle or average status; 4 is upper middle; and 5 is upper status. SES estimates and ethnicity are provided only to indicate the heterogeneity of the subject population. The wide range of race and economic status represented suggests that results of the ICTS demonstration cannot be attributed to demographic selection factors.

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*Persons are said to have only "light perception" if, even with the help of ordinary corrective lenses, the vision in the better eye is such that they can only detect a light intensity when looking in a particular direction.

Persons are said to have only "light projection" if, even with the help of ordinary corrective lenses, the vision in the better eye is such that they can visually detect very bright areas in a scene (especially those that are sources of illumination), and if they can also detect opaque objects that cut off from the field of view all or part of the light from these bright areas in the scene.

The diagnostic data used to determine subject eligibility are found in Table 2.3. Diagnosis of visual pathologies were provided by the students' ophthalmologists, as reported in their cumulative school district files. Acuities were measured by project optometrists. Nonvisual handicapping conditions were assessed by teachers, testing psychologists, and medical professionals, as reported in the students' cumulative files.

To summarize the data in Tables 2.2 and 2.3, of the 21 participating subjects, there were seven females and 14 males. Racially, the sample was balanced, including seven Black, seven Chicano, and seven White students. Socioeconomic estimates found most students in the lower range, only two were judged to rank above average by teachers. Over 65 percent of our subjects were legally blind; over 75 percent had two or more visual pathologies, including 10 cases of nystagmus and four cases each of optic nerve atrophy, albinism, high myopia, and retinitis pigmentosa. Half of the subjects had nonvisual handicapping conditions in addition to their visual impairment. Finally, IQ estimates spanned the range from 64 through 137, with a median score of 97. In short, despite the small number of subjects, those who did participate represented a wide diversity within the demographic and diagnostic variables surveyed. As Table 2.2 notes, eight subjects left the project prior to its completion. Among them, three subjects matriculated to a junior high school program for the visually handicapped; reports from these programs indicated that as of spring 1978 subjects 102 and 103 continued well below grade normal, while subject 101 was functioning at expected grade level for her age, according to standardized achievement test scores. Four subjects' families moved from their respective districts. One subject (214) was dropped as a project subject because his functional near-vision ability did not appear to require ICTS intervention. No subject left the project for reasons related to the ICTS intervention.

Table 2.3

DIAGNOSTIC DATA

Subject Number	Visual Pathology	Acuity[a]	PS[b]	LB[b]	Other Handicaps	IQ
101	Optic nerve atrophy, nystagmus	20/200		X	Cerebral palsy	74 Slossen
102	Amblyopia, high myopia	20/80	X		Educable Mentally Retarded	64 Slossen
103	Optic nerve atrophy, intermittent exotropia	20/1200		X		124 Slossen
104	Congenital coloboma of the retina	20/400		X		137 Slossen
105	Congenital cataracts, nystagmus, strabismus	20/240		X		109 Slossen
107	Congenital optic nerve atrophy	20/400		X		109 WIPPSI
201	Congenital nystagmus, coloboma of the retina, congenital cataracts, microphthalmia	20/400		X		97 WISC-R
203	Pathological myopia, amblyopia, strabismus	20/80	X		Educable Mentally Retarded, premature birth, hyperactive	73 WISC-R
204	Congenital glaucoma, congenital cataracts, surgical complications	20/640		X	Physically immature, emotional problems likely due to multiple operations (25 to date)	75 WIPPSI
205	Intraocular tumors	20/160	X		Possibly hyperactive	111 WIPPSI
206	Albinism, nystagmus	20/100	X		Emotionally immature	79 WIPPSI
207	Optic atrophy, nystagmus	20/120		X[c]		114 WIPPSI
208	Albinism, nystagmus	20/200		X	Sickle-cell anemia	87 WIPPSI
210	Congenital retinal folds, retinal detachment, chorioretinitis, nystagmus	20/200		X	Hyperactive, neurological impairment, epileptic (heavily medicated with Ritalin and Dilantin)	82 WISC-R
211	Bilateral aphakia, nystagmus (cataracts removed at 8 months)	20/700	X			100 WISC-R
212	Retinitis pigmentosa, moderately high myopia	20/200		X		99 WIPPSI
213	Albinism with nystagmus	20/120		X[c]		119 WISC-R
214	Retinal degeneration	20/120	X			67 WIPPSI
215	Albinism with nystagmus, exotropia	20/120	X		Sickle-cell anemia, obesity, gait disorder	82 WISC-R
216	Advanced retinitis pigmentosa	20/360		X		112 WISC-R
217	Possible retinal degeneration, high myopia	20/320		X		92 WISC-R

[a]Many students had impaired fields; however, field measures have been omitted because of the lack of standardized ways of representing their perimetry.

[b]PS = partially sighted; LB = legally blind; based on acuity measures only.

[c]Subjects classified legally blind because of measured field restriction of 20° or less.

DATA ANALYSIS

Because the number of subjects enrolled in the project during any given year was small and because there was little reason to expect normally distributed data, evaluation outcomes within years were investigated primarily by the use of nonparametric analyses relying only on ordinal properties of scores. Examining pre-to-post changes was of primary interest. For this purpose, Wilcoxen matched-pairs signed-ranks tests (within subjects) were used. In the case of scores derived from binary items among the psychosocial measures, such analyses were supplemented by binominal tests of the probability of change in a given direction. Between-subjects comparisons exploring outcome differences as a function of such factors as site or age group (grades one through three versus grades four through six) were assessed with the Mann Whitney U statistic.

In order to investigate changes in outcomes within subjects over time, longitudinal analyses were undertaken at the end of the project. For this purpose, data were grouped on the basis of "participation year" for all subjects for whom at least two years of measures were available. Defining Participation Years I and II as a subject's first and second year of enrollment in the project (independently of calendar year) generated a sufficiently large sample for repeated measures analyses of variance. Longitudinal analyses employ both time of measurement (pre-to-post) and Participation Year (I and II) as repeated independent factors; where appropriate, such analyses also include grade- or age-group as crossed independent factors. In addition, attrition studies were conducted to determine whether performance changes established by longitudinal analyses should be attributed to the experimental intervention or to selective disenrollment in the project. For this purpose, subjects were divided into two subsamples: those for whom two or more participation years of data were available, and those who participated one year only. All outcomes examined longitudinally were also explored on a between-subjects basis to determine whether any evaluation variables significantly differentiated the attrition group from the subjects who remained in the project.

Observation data required a different sort of analytic approach. For these data, participant group is the appropriate unit of analysis since scores represent percent of subjects observably engaged in a variety of specific behaviors at a number of points in time. During the first project year, subjects were grouped on the basis of site; during the remaining years, subjects at the Killian site were further subdivided on the basis of age group. Data were pooled within group over occasion of observation to yield one score per variable per day. Such scores were examined between groups within project year. In addition, comparisons were made within groups between selected variables and between years. For this purpose, parametric T tests were used.

III. ACADEMIC ACHIEVEMENT

TEST SELECTION AND ADMINISTRATION

The first objective of the demonstration project was to determine the effect of the ICTS on academic achievement in the basic elementary school skill areas of verbal and quantitative proficiency. Selection of instruments from the large pool of available achievement tests was guided by the following criteria:

- Item content should be recently revised, relevant to expected curriculum, reasonably interesting to subjects, and suitable for indexing a broad range of abilities (through multiple forms, if necessary).
- The test should be reliable and valid, well documented and reviewed.
- The test must be susceptible to administration by a teacher or special education testing psychologist on an individual basis, using the ICTS if necessary for magnification.
- Test procedures as well as test content must be standardized, with scoring provided by the test supplier.
- The test must have national norms and should yield, in addition to raw scores, more useful transformed data in the form of percentile ranks, standard scores, or grade or age equivalents.
- Resulting information should be useful for delineating specific kinds of progress and specific areas in which improvement is needed, and not just useful for screening purposes.

With these guidelines in mind, we were unable to select a single suitable evaluative instrument. The two choices that came closest to fulfilling our criteria were the Wide Range Achievement Test (perhaps the most extensively used of all achievement batteries) and the newer Peabody Individual Achievement Test. However, both tests

failed to meet the last criterion, as they provide only rough general achievement indicators and are mainly useful for screening. We therefore decided to use the Comprehensive Test of Basic Skills (CTBS, National Testing Service, reviewed in Buros, 1972) for children performing at the first grade level or above, and a subset of the CIRCUS battery (CIRCUS 1, 2, 5, and 8, Educational Testing Service, reviewed in *Proceedings of the American Psychological Association*, 1973) for students performing at preacademic levels.

The CTBS is constructed to represent the primary level and four additional ability ranges (grades 2.5 to 4, 4 to 6, 6 to 8, 8 to 12), with alternate forms available for each ability range. CTBS subtest scores correlate highly with those of the California Achievement Tests, and their content validity is substantiated by the detailed account of test construction procedures in the CTBS Technical Report. Of particular value for this evaluation, each test response is classified according to the cognitive process it presupposes; thus errors directed attention to the specific areas in which each student needs improvement.

For children who fell within the age and intelligence constraints of the ICTS project, but whose abilities were still at the preprimary level, we used the CIRCUS subtests *What Words Mean* (No. 1: receptive vocabulary), *How Words Work* (No. 8: functional language), *How Much and How Many* (No. 2: quantitative concepts), and *Letters and Numbers* (No. 5: letter and number recognition). Like the CTBS, this instrument was designed to yield accounts of individual strengths and weaknesses within areas measured.

All achievement tests were administered by the ICTS classroom teachers. Practice items supplied by the testing service were used to determine whether each child was ready on testing day to take the test in a way that would be representative of typical performance level; illness, fatigue, excitement, anxiety, and other potential disrupters of performance manifested during the trial period were considered grounds for rescheduling. Tests were administered on an individual basis, using the standardized test booklets according to

directions provided in the administration manual, with the following exceptions:

- o Subtests were spaced over several sessions.
- o The teacher read items to the students when necessary.
- o When visual material was an adjunct to either questions or answers, the teacher displayed that material from the test booklet for the child on an ICTS monitor. (This procedure is similar in principle to the practice of enlarging test booklet materials; while the latter practice is more common, it is much more cumbersome and seldom produces the magnification and high contrast of which the ICTS is capable.)
- o Answer sheets were submitted to the testing service (either NTS or ETS) for scoring.
- o For any child who had not changed in ability range between the time of the first post-testing and the next occasion of achievement test administration, an alternate form of the achievement test was used.

Except for newly entering subjects, spring post-test data from 1976 and 1977 served as premeasures for the next year's evaluation of achievement. To ensure that no large or erratic changes in scores were occurring between each spring and the following fall, scores from spring 1975 were compared with those from fall 1975. This comparison established that achievement changes during the summer months were negligible (Wilcoxen $\underline{T}$ = 7, not significant).*

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*The nonparametric Wilcoxen matched-pairs signed-ranks test relies on difference scores obtained from two related sets of observations; their magnitude and direction are used to determine whether the sets of observations differ significantly (Siegel, 1956, pp. 75-83).

CTBS RESULTS

Year One

Scores from the 1975-1976 administration of the CTBS are presented in Table 3.1, which is organized along the following lines. Subject numbers are given first, along with information about the subject's "normal" grade at post-test time (May 1976). While visually impaired students are not expected to perform at the level indicated by the norms derived from fully sighted students, these figures provide a basis for interpreting obtained scores, for comparing students at different grade levels, and for estimating school year progress. Data for reading and mathematics are then given, in this order: the post-test score is represented in terms of its grade equivalent and is followed by a number in parentheses representing the difference between the obtained score and the grade normal score for the subject; next the pre-test score is given, in grade equivalent terms; and finally, the pre-to-post change is displayed in terms of gains or losses in grade equivalents. The last column subtracts the mathematics score from the reading score, to establish whether subjects tend to achieve at systematically higher or lower levels in either skill area (a minus indicates superior performance in mathematics, while a plus shows relative superiority in reading).

The five subjects in the 100 series (Site I) are Madison subjects; subjects in the 200 series (Site II) are Killian students. It should be noted that the pre-test score for subject 205 is theoretical. This student was untestable using the CTBS in the fall, but needed a first grade level test in the spring. Consequently, for data analysis purposes he was awarded a pre-test score of 1.0, interpreted as very beginning first grade. The total number of subjects for whom CTBS data are available, then, is eight. Unless otherwise specified, statistical treatments are nonparametric and rely only on ordinal properties of the data.

Examining the pre-to-post changes was our primary interest. For this purpose, we employed a Wilcoxen matched-pairs signed-ranks test. In both reading ($T = 4.5$, $p < .05$) and mathematics ($T = 3$, $p < .025$), students' scores showed significant gains. Looking at change scores

Table 3.1

CTBS SCORES, 1975-1976

Subject	Grade Normal	Reading				Mathematics				Post-test: Reading - Mathematics
		Post-test Score	Distance from Grade Normal	Pre-test Score	Pre-Post Change	Post-test Score	Distance from Grade Normal	Pre-test Score	Pre-Post Change	
Site I										
101	6.9	5.4	-1.5	4.6	+0.8	4.9	-2.0	5.2	-0.3	+0.5
102	5.9	1.8	-4.4	1.5	+0.3	3.7	-2.2	2.9	+0.8	-1.9
103	3.9	3.3	-0.6	3.6	-0.3	4.0	+0.1	3.8	+0.2	-0.7
104	4.9	5.2	+0.3	5.8	-0.6	5.9	+1.0	4.4	+1.5	-0.7
105	1.9	1.5	-0.4	0.6	+0.9	2.1	+0.2	0.5	+1.6	-0.6
Site II										
201	3.9	3.0	-0.9	2.3	+0.7	2.5	-1.4	2.5	0	+0.5
203	6.9	3.1	-3.8	2.3	+0.8	3.3	-3.6	3.2	+0.1	-0.2
205	1.9	1.8	-0.1	1.0[a]	+0.8	2.7	+0.8	1.0[a]	+1.7	-0.9
210	6.9	2.3	-4.6	2.3	0	3.6	-3.3	1.6	+2.0	-1.3
Means			-1.8		+0.4		-1.24		+0.8	-0.6

[a]Theoretical beginning first grade score; this student was untestable in the fall on the lowest level of the CTBS.

and post-test outcomes, it was our view that by the end of the first year, students were progressing at a promising rate on the whole. There was a tendency for Madison subjects to be closer to grade normal at post-test time in both skill areas, although the between-group difference does not reach statistical significance as assessed by a Mann-Whitney U test.* This result is not surprising, in view of the fact that the Madison classroom had had the ICTS a year longer than the Killian classroom. (As we shall see later, reading and mathematics achievement are both highly correlated with visually dependent skills; and the latter should be enhanced by ICTS use.) There was a similar tendency for students nominally in grades four through six to be farther from grade normal than students in grades one through three ($U = 3$, $p < .10$). This result reflects the cumulative aspect of educational deficits and suggests that it is important for partially sighted students to have access to an ICTS early in their school experience. Finally, the last column in Table 3.1 shows the relationship between reading and mathematics scores. This relationship was examined by means of a Wilcoxen T test, which indicated that as of spring 1976, the ICTS students were significantly closer to grade normal in mathematics than in reading ($T = 5$, $p < .05$). We found this relationship to hold true of fall 1975 scores as well, despite the high correlation between mathematics and reading achievement. We believe that the relative superiority of these subjects in mathematics during the first year was accounted for by the fact that performing computations requires less scanning and visual retention than does reading (see review in Mackworth, 1969).

Year Two

Table 3.2 presents CTBS data for 1976-1977, organized in the same manner as the preceding table. Once again, we used a Wilcoxen matched-pairs signed-ranks test ($n = 10$) to examine changes. In

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*Given two independent sets of observations, the nonparametric Mann-Whitney U test provides a means of determining, on the basis of the ranks of the pooled scores, whether they differ significantly (Siegel, 1956, pp. 116-127).

Table 3.2

CTBS SCORES, 1976-1977

Subject	Grade Normal	Reading				Mathematics				Post-test: Reading - Mathematics
		Post-test Score	Distance from Grade Normal	Pre-test Score	Pre-Post Change	Post-test Score	Distance from Grade Normal	Pre-test Score	Pre-Post Change	
Site I										
102	6.9	2.1	-4.8	1.8	+0.3	4.0	-2.9	3.7	+0.3	-1.9
103	4.9	5.1	+0.2	3.3	+1.8	5.8	+0.9	4.0	+1.8	-0.7
104	5.9	6.1	+0.4	5.2	+0.9	6.7	+0.8	5.9	+0.8	-0.4
Site II										
201	4.9	5.1	+0.2	3.0	+2.1	3.4	-1.5	2.5	+0.9	+1.7
203	7.9	4.8	-3.1	3.1	+1.7	3.0	-4.9	3.3	-0.3	+1.8
210	7.9	3.5	-4.4	2.3	+1.2	4.4	-3.5	3.6	+0.8	-0.9
211	1.9	1.7	-0.2	0.1	+1.6	1.3	-0.6	0.1	+1.2	+0.4
213	4.9	5.7	+0.8	5.5	+0.2	5.1	+0.2	4.0	+1.1	+0.6
214	2.9	1.9	-1.0	1.2	+0.7	1.8	-1.1	0.1	+1.7	+0.1
215	6.9	4.9	-2.0	2.2	+2.7	3.3	-3.6	3.6	-0.3	+1.6
Means			-1.39		+1.32		-1.62		+0.8	+0.2

mathematics, students' scores showed a significant increase from fall to spring ($T = 4$, $p < .02$), gaining eight months on the average during a ten-month school year. This rate of achievement compares favorably with average school year gains for lower income and minority students such as ours who do not have visual impairment (cf. Deutsch, 1963; Hunt, 1969; Singer et al., 1975; Crain and Mahard, 1977). At year end, however, students remained significantly below grade normal ($T = 8$, $p < .05$); on the average they were 1.6 years behind the fully sighted norming sample for their grade level. In reading, students' scores improved even more dramatically from fall to spring ($T = 0$, $p < .01$), gaining an average of 1.3 years in one school year. This rate of achievement is remarkable, since it is well ahead of the normal gain. While the students remained about 1.4 years behind grade normal in reading, these differences did not reach statistical significance ($T = 35$, p = n.s.).

Year Three

By the third year of the study, only one of thirteen ICTS participants was performing at the preacademic level and required testing with the CIRCUS battery. All the others received verbal and mathematics subtests of the CTBS.

Table 3.3 presents the CTBS data similarly organized for 1977-1978. That is, each subject is represented in terms of normal grade. The next four columns provide the reading achievement grade-equivalent score at post-test time and pre-test time, along with the post-test difference from grade normal and the pre-to-post change. The same information is tabled for mathematics achievement in the following three columns, followed by the reading-mathematics achievement difference.

A Wilcoxen matched-pairs signed-ranks test ($n = 12$) showed significant increases in both reading and mathematics scores from fall to spring ($T = 0$, $p < .01$); gains averaged 1 year and 7 months, and 1 year and 5 months, respectively. This gain far exceeds the normal expected rate of advance for fully sighted students. While the ICTS students continued to decrease the gap between obtained and grade normal scores,

Table 3.3

CTBS SCORES, 1977-1978

Subject	Grade Normal	Reading				Mathematics				Post-test: Reading - Mathematics
		Post-test Score	Distance from Grade Normal	Pre-test Score	Pre-Post Change	Post-test Score	Distance from Grade Normal	Pre-test Score	Pre-Post Change	
Site I										
103	5.9	5.4	-0.5	5.1	+0.3	7.1	+1.2	5.8	+1.3	-1.7
104	6.9	7.8	+0.9	6.3	+1.5	6.5	-0.4	6.7	+0.9	+1.3
Site II										
201	5.9	6.9	+0.11	5.1	+1.8	5.7	-0.3	3.4	+2.3	+1.2
204	3.9	0.3	-3.7	0.2	+0.1	0.6	-3.4	0.1	+0.5	-0.3
207	2.9	1.9	-1.1	1.7	+0.2	4.5	+1.7	3.2	+1.3	-2.6
208	2.9	1.6	-1.4	0.1	+1.5	1.6	-1.4	1.2	+0.4	+0.0
210	8.9	5.0	-3.10	3.5	+1.5	5.0	-3.1	4.4	+0.6	+0.0
212	2.9	1.9	-1.1	1.7	+0.2	2.9	-0.1	1.5	+1.4	-1.0
213	5.9	10.0	+4.2	5.7	+4.3	7.0	+1.2	5.1	+1.9	+3.0
215	7.9	6.3	-1.7	4.9	+1.4	5.6	-2.4	3.3	+2.3	+0.7
216	4.9	7.1	-2.3	4.3	+2.8	6.5	+1.7	5.2	+1.3	+0.6
217	4.9	7.1	-2.3	3.4	+3.7	5.7	+0.9	2.8	+2.9	+1.4
Means			-0.2		+1.6		-0.4		+1.3	+0.2

they remained an average of 3 months behind in reading and 4 months behind in mathematics; the difference between post-test scores and grade normal is not, however, statistically significant in either subject area. This outcome is noteworthy in view of three points: Site II ICTS subjects are now closer to grade normal, on the average, than most fully sighted students of similar socioeconomic status; the trend toward increasing distance from grade normal as grade level increases has been curtailed; and there is no demonstrable systematic difference overall between ICTS students and normally sighted peers in achievement.

CIRCUS RESULTS

Year One

Information from the 1975-1976 administrations of the CIRCUS basic skill battery to younger subjects in the Killian classroom is summarized in Table 3.4 and presented in detail in Tables 3.5 and 3.6. The CIRCUS battery chosen for evaluating preacademic (kindergarten and prekindergarten) levels of basic skills in students includes two "verbal" or prereading tests (CIRCUS 1 and 8) and two "quantitative" or premathematical tests (CIRCUS 2 and 5). Table 3.4 gives total pre- and post-test scores for each subject in both skill areas, along with the pre-to-post change. Wilcoxen matched-pairs signed-ranks tests indicated that subjects improved significantly on both verbal ($T = 0$, $p < .01$) and quantitative ($T = 2$, $p < .01$) assessments. No comparison can be drawn between outcomes in the two basic skill areas, however; these tests are normed below the first grade level, and scores do not map onto a common developmental age equivalent scale.

Because the number of subjects at the preacademic level was so small, and because their achievement cannot be compared either with grade or age norms or with the performance of older subjects, we have chosen to present a detailed descriptive account of their test performance rather than to attempt any statistical analyses. Table 3.5 breaks down the two verbal achievement tests into their components in the following fashion. After the subject identification number and age in years and months at post-test, information is tabled in exactly

Table 3.4

SUMMARY OF CIRCUS SCORES, 1975-1976

	Total Verbal				Total Quantitative			
Subject	Sub-test	Post-test	Pre-test	Pre-Post Change	Sub-test	Post-test	Pre-test	Pre-Post Change
204	1	14	12	+2	5	8	10	- 2
	8	15	12	+3	2	22	13	+ 9
206	1	28	19	+9	5	12	4	+ 8
	8	22	15	+7	2	28	22	+ 6
207	1	18	16	+2	5	18	18	0
	8	20	16	+4	2	36	23	+13
208	1	23	18	+5	5	12	9	+ 3
	8	14	9	+5	2	28	20	+ 8

the same manner for CIRCUS 1 (*What Words Mean*) and CIRCUS 8 (*How Words Work*). Initially, the total pre-test and post-test scores are given, followed by the percentile ranks of those scores in relation to national kindergarten percentile norms.* Finally, an interpretation of the configuration of obtained scores is derived from the test manual and reproduced below the student's outcome array. The first comment refers to the pre-test configuration, while the second comment describes the post-test display.

Table 3.6 breaks down the remaining two achievement tests, CIRCUS 2 (*How Much and How Many*) and CIRCUS 5 (*Letters and Numbers*), in exactly the same way. That is, absolute scores and percentiles based on national kindergarten norms are given for the total test on a pre-post basis; scores are followed by interpretive comments generated for each subject on the basis of the outcome pattern for test items.

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*Percentile rank indicates the percent of kindergarteners in the national sample who scored below the range in which the subject's obtained score fell.

Table 3.5

CIRCUS SCORE COMPARISONS: VERBAL ACHIEVEMENT TESTS, 1975-1976

Subject	Age in Years and Months	Pre-test Score	Post-test Score	Percentile Rank
				CIRCUS 1: WHAT WORDS MEAN
204	6-10	12	14	(pre) 2% scored in range, 0% below. (post) Same.
				Sentence reports: (*pre*) Appears to lack competence in receptive vocabulary skills; needs instruction and practice. (*post*) Appears to lack competence in receptive vocabulary skills; needs instruction and practice.
206	6-1	19	28	(pre) 65% scored in range, 35% below. (post) 64% scored in range, 20% below.
				Sentence reports: (*pre*) Responded correctly to a number of the receptive vocabulary items, but needs more instruction and practice. (*post*) Generally competent in receptive vocabulary skills; needs additional help with nouns.
207	5-5	16	18	(pre) 65% scored in range, 35% below. (post) Same.
				Sentence reports: (*pre*) Responded correctly to a number of the receptive vocabulary items, but needs more instruction and practice. (*post*) Generally competent in receptive vocabulary skills; needs additional help with nouns.
208	5-8	18	23	(pre) 65% scored in range, 35% below. (post) 17% scored in range, 11% below.
				Sentence reports: (*pre*) Responded correctly to a number of the receptive vocabulary items, but needs more instruction and practice. (*post*) Generally competent in receptive vocabulary skills; needs additional help with nouns.
				CIRCUS 8: HOW WORDS WORK
204	6-10	12	15	(pre) 1% scored in range, 0% below. (post) 14% scored in range, 1% below.
				Sentence reports: (*pre*) Appears to lack competence in receptive functional language, or had difficulty with test tasks; needs instruction and practice. (*post*) Responded correctly to most items involving discrimination between sentences with different structures; needs further instruction and practice in discrimination between verb forms and prep./neg./conj.
206	6-1	15	22	(pre) 14% scored in range, 1% below. (post) 76% scored in range, 39% below.
				Sentence reports: (*pre*) Responded correctly to most items involving prep./neg./conj.; needs more work with syntax and verb forms. (*post*) Generally competent in discrimination between verb forms and prep./neg./conj.; but had difficulty discriminating between sentences with different structures.
207	5-5	16	20	(pre) 14% scored in range, 9% below. (post) 76% scored in range, 16% below.
				Sentence reports: (*pre*) Needs further instruction and practice in all aspects of receptive functional language assessed by CIRCUS 8. (*post*) Responded correctly to most items involving prep./neg./conj. and those involving sentences with different structures; had difficulty discriminating between verb forms.
208	5-8	9	14	(pre) 1% scored in range, 0% below. (post) 14% scored in range, 1% below.
				Sentence reports: (*pre*) Appears to lack competence in receptive functional language, or had difficulty coping with test tasks; needs further inst./practice. (*post*) Needs further instruction and practice in all aspects of receptive functional language assessed by CIRCUS 8.

Table 3.6

CIRCUS SCORE COMPARISONS: QUANTITATIVE ACHIEVEMENT TESTS, 1975-1976

Subject	Age in Years and Months	Pre-test Scores	Post-test Scores		Percentile Rank
			CIRCUS 2: HOW MUCH AND HOW MANY		
204	6-10	13	22	(pre) (post)	3% scored in range, 0% below. 64% scored in range, 19% below.
	Sentence reports: (*pre*) Appears to lack quantitative competence or had difficulty coping with test tasks; needs further instruction. (*post*) Generally competent quantitative skills and understanding, needs additional help with relational terms.				
206	6-1	22	28	(pre) (post)	64% scored in range, 19% below. 64% scored in range, 24% below.
	Sentence reports: (*pre*) Needs further instruction and practice with quantitative concepts. (*post*) Responded correctly to many of the quantitative items, but needs additional help with counting and relational terms.				
207	5-5	23	36	(pre) (post)	64% scored in range, 19% below. 17% scored in range, 83% below.
	Sentence reports: (*pre*) Responded correctly to many of the quantitative items, but needs additional help with counting and relational terms. (*post*) Generally competent in quantitative skills and understanding. Subject may be approaching operations level of development.				
208	5-8	20	28	(pre) (post)	15% scored in range, 10% below. 64% scored in range, 29% below.
	Sentence reports: (*pre*) Needs further instruction and practice with quantitative concepts. (*post*) Responded correctly to many of the quantitative items, but needs additional help with counting.				
			CIRCUS 5: FINDING LETTERS AND NUMBERS		
204	6-10	10	8	(pre) (post)	58% scored in range, 19% below. 18% scored in range, 1% below.
	Sentence reports: (*pre*) Appears to lack competence in recognizing letters and numbers. Needs further instruction and practice. (*post*) Generally competent in recognizing lower case letters, but needs additional help with capital letters and numbers.				
206	6-1	4	12	(pre) (post)	18% scored in range, 1% below. 58% scored in range, 19% below.
	Sentence reports: (*pre*) Appears to lack competence in recognizing letters and numbers; needs further instruction and practice. (*post*) Generally competent in recognizing capital letters, but may need additional help with lower case letters and numbers.				
207	5-5	18	18	(pre) (post)	58% scored in range, 58% below. Same.
	Sentence reports: (*pre*) Generally competent in recognizing letters and numbers. (*post*) Generally competent in recognizing letters and numbers.				
208	5-8	9	12	(pre) (post)	18% scored in range, 1% below. 58% scored in range, 19% below.
	Sentence reports: (*pre*) Appears to lack competence in recognizing letters and numbers; needs further instruction and practice. (*post*) Generally competent in recognizing letters and numbers, but needs additional help with capital letters.				

In general, both the outcomes and the comments indicate that during the first year of the study, younger subjects improved in most aspects of verbal and quantitative performance. More importantly, the post-test percentile scores (indicating the number of kindergarteners in the national norming sample who scored below the decile range in which the subject's score fell) presented a rather optimistic picture. Considering all 16 post-test scores for the four tests, only three fell in the bottom 10 percent; six scores fell in the second decile; five scores fell in the third decile; and two scores were in the upper 50 percent. In view of the circumstance that the percentile norms were obtained from visually unimpaired subjects of the same age, along with the fact that Killian subjects had only a half year's use of the ICTS, we found the post-test performance of our preacademic subjects very promising.

Year Two

Tables 3.7, 3.8, and 3.9 provide CIRCUS information obtained for preacademic students during 1976-1977. These subjects (n = 4) were all members of the younger student subgroup at the Killian site. Table 3.7 gives total pre- and post-test scores for each subject in verbal and quantitative skills, along with the pre-to-post change.

Table 3.7

SUMMARY OF CIRCUS SCORES, 1976-1977

	Total Verbal				Total Quantitative			
Subject	Sub-test	Post-test	Pre-test	Pre-Post Change	Sub-test	Post-test	Pre-test	Pre-Post Change
204	1	14	14	0	2	27	22	+5
	8	16	15	+ 1	5	10	8	+2
207	1	29	18	+11	2	39	36	+3
	8	20	20	0	5	19	18	+1
208	1	33	23	+10	2	35	28	+7
	8	20	14	+ 6	5	18	12	+6
212	1	30	22	+ 8	2	34	29	+5
	8	20	17	+ 3	5	19	17	+2

Table 3.8

CIRCUS SCORE COMPARISONS: VERBAL ACHIEVEMENT TESTS, 1976-1977

Subject	Age in Years and Months	Pre-test Score	Post-test Score	Percentile Rank
				CIRCUS 1: WHAT WORDS MEAN
204	7-9	14	14	(pre) 2% scored in range, 0% below. (post) Same.
				Sentence reports: *(pre)* Appears to lack confidence in receptive vocabulary skills. Probably needs further instruction and practice. *(post)* Same.
207	6-4	18	29	(pre) 17% scored in range, 2% below. (post) 64% scored in range, 20% below.
				Sentence reports: *(pre)* Responded correctly to a number of the receptive vocabulary items, but needs more instruction and practice. *(post)* Generally competent in receptive vocabulary skills, but may need additional help with verbs and modifiers.
208	6-8	23	33	(pre) 17% scored in range, 11% below. (post) 64% scored in range, 60% below.
				Sentence reports: *(pre)* Responded correctly to a number of the receptive vocabulary items, but needs more instruction and practice. *(post)* Generally competent in receptive vocabulary skills.
212[a]	6-10	18	29	(pre) 17% scored in range, 5% below. (post) 64% scored in range, 39% below.
				Sentence reports: *(pre)* Responded correctly to a number of the receptive vocabulary items, but probably needs further instruction and practice with nouns and verbs. *(post)* Generally competent in receptive vocabulary skills.
				CIRCUS 8: HOW WORDS WORK
204	7-9	15	16	(pre) 14% scored in range, 1% below. (post) 14% scored in range, 9% below.
				Sentence reports: *(pre)* Responded correctly to most items involving discrimination between sentences with different structures; needs further instruction and practice in discrimination between verb forms and statements involving prepositions/negation/conjunctions. *(post)* Responded correctly to most items involving discrimination between verb forms, but probably needs further instruction and practice in discriminating between statements involving prep./neg./conj., and between sentences with different structures.
207	6-4	20	20	(pre) 76% scored in range, 16% below. (post) Same.
				Sentence reports: *(pre)* Generally competent in discriminating between verb forms and between statements involving prep./neg./conj., but had difficulty discriminating between sentences with different structures. *(post)* Same.
208	6-8	14	20	(pre) 14% scored in range, 1% below. (post) 76% scored in range, 16% below.
				Sentence reports: *(pre)* Needs further instruction in all aspects of receptive functional language assessed by CIRCUS 8. *(post)* See above, pre-sentence report for No. 207.
212[a]	6-10	17	20	(pre) 14% scored in range, 9% below. (post) 76% scored in range, 16% below.
				Sentence reports: *(pre)* Probably needs further instruction and practice in all aspects of receptive functional language assessed by CIRCUS 8. *(post)* See above, pre-sentence report for No. 207.

[a]Subject 212 entered 9/76.

Table 3.9

CIRCUS SCORE COMPARISONS: QUANTITATIVE ACHIEVEMENT TESTS, 1976-1977

Subject	Age in Years and Months	Pre-test Score	Post-test Score	Percentile Rank
				CIRCUS 2: HOW MUCH AND HOW MANY
204	7-9	22	27	(pre) 15% scored in range; 10% below. (post) 64% scored in range; 19% below.
	Sentence reports: *(pre)* Probably needs further instruction and practice with quantitative concepts especially relational terms. *(post)* Generally competent quantitative skills and understanding, but may need additional help with relational terms.			
207	6-4	36	39	(pre) 64% scored in range; 61% below. (post) 17% scored in range; 83% below.
	Sentence reports: *(pre)* Generally competent in quantitative skills and understanding. Subject may be approaching operations level of development. *(post)* Very competent in quantitative skills and understanding.			
208	6-8	28	35	(pre) 64% scored in range; 29% below. (post) 64% scored in range; 61% below.
	Sentence reports: *(pre)* Responded correctly to many of the quantitative terms, but needs additional help with counting. *(post)* Generally competent in quantitative skills and understanding; may be approaching operations level of development.			
212[a]	6-10	29	34	(pre) 64% scored in range; 29% below. (post) 64% scored in range; 61% below.
	Sentence reports: *(pre)* Responded correctly to many of the quantitative terms, but needs additional help with counting. *(post)* Generally competent in quantitative skills and understanding; may be approaching operations level of development.			
				CIRCUS 5: FINDING LETTERS AND NUMBERS
204	7-9	8	10	(pre) 18% scored in range; 1% below. (post) 58% scored in range; 19% below.
	Sentence reports: *(pre)* Appears to lack competence in recognizing letters and numbers. Needs further practice and instruction. *(post)* Probably needs further instruction and practice in recognizing letters and numbers.			
207	6-4	18	19	(pre) 58% scored in range; 58% below. (post) 23% scored in range; 77% below.
	Sentence reports: *(pre)* Generally competent in recognizing letters and numbers. *(post)* Very competent in recognizing letters and numbers.			
208	6-8	12	18	(pre) 58% scored in range; 19% below. (post) 58% scored in range; 58% below.
	Sentence reports: *(pre)* Generally competent in recognizing letters and numbers, but may need additional help with capital letters. *(post)* Generally competent in recognizing letters and numbers.			
212[a]	6-10	17	19	(pre) 58% scored in range; 58% below. (post) 23% scored in range; 77% below.
	Sentence reports: *(pre)* Generally competent in recognizing letters and numbers. *(post)* Very competent in recognizing letters and numbers.			

[a]Subject 212 entered 9/76.

For purposes of summary analysis, scores on the two subtests for each skill are pooled. Wilcoxen matched-pairs signed-ranks tests indicated that subjects improved significantly on both verbal ($T = 0$, $p < .01$) and quantitative ($T = 0$, $p < .01$) assessments. These results are similar to the findings for the first year at the preacademic level, and suggest stable progress for the younger subjects.

Because the number of preacademic students remained so small as to preclude statistical analysis, we continued the practice of representing their performance in detailed descriptive terms. Table 3.8 breaks down the two verbal achievement tests in the following way. After the subject identification number and age at post-test, total scores for CIRCUS 1 pre-test and post-test are given; then the pre- and post-percentile ranks are noted; finally information is presented about the location of the subject's score and about the distribution of the subject's abilities (given the specific pattern of items passed and failed in the subtest) for both pre- and post-tests. These data are followed by data from CIRCUS 8 arranged in exactly the same way. Table 3.9 presents information similarly organized for the two premathematical subtests.

In general, the pattern of scores and the interpretive comments indicated that younger subjects were improving in most aspects of verbal and quantitative performance. Post-test percentile scores presented quite an optimistic picture. Considering all sixteen post-test scores for the four tests, only two fell in the bottom 10 percent; six scores fell in the second decile; one score fell in the fourth decile; and seven scores were in the upper 50 percent. This distribution represents quite an advance over the first year. Interestingly, the lower decile scores came primarily from prereading tests, with only two scores from premathematics subtests falling below the fiftieth percentile; this result seems to parallel the CTBS finding that subjects develop quantitative skills before verbal skills.

Year Three

In 1977-1978, only one subject fell below the range of the CTBS and required the preprimary achievement test. Table 3.10 provides CIRCUS information for this subject, tabled as before. While no inferences can be drawn from data for a single subject, two points are worth noting. First, as a newly entering subject, 107 gained markedly in all four test areas. And, like new ICTS subjects in previous years, 107's strongest initial gains were in numerical skills. This pattern replicates the performance of larger subject groups in previous years.

LONGITUDINAL ANALYSES

Longitudinal analyses were undertaken at the end of the project, in order to investigate changes in basic academic skill measures within subjects over time. Previous analyses explored intervention effects within project years. However, because subjects entered and left the project during all three years (see Table 2.2), comparing outcomes from year to year provides an evaluation of program progress but does not assess long-term individual change. For this purpose, data were grouped on the basis of "participation year" for all subjects for whom at least two years of outcome measures were available. Participation Year I is defined as the first year of a subject's enrollment and Participation Year II as the second year of enrollment, regardless of project year. Controlling intervention time by using participation year as an independent variable permitted combining subjects over site and over project year to generate a sample sufficiently large for repeated measures analyses of variance.[*] Participation year and pre-post change, then, both served as repeated independent factors. This treatment of the data characterizes longitudinal analyses throughout the report.[†]

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[*]Analysis of variance is a parametric method for determining what proportion of variation in scores can be systematically attributed to specified independent factors (Fisher, 1960).

[†]Instead of using participation year and pre-post change as two two-level repeated factors, it would be just as appropriate analytically

Table 3.10

CIRCUS SCORE COMPARISONS, 1977-1978

Subject	Age in Years and Months	Pre-test Score	Post-test Score		Percentile Rank
					CIRCUS 1: WHAT WORDS MEAN
107	6-1	24	27	(pre) (post)	17% scored in range, 11% below. 64% scored in range, 20% below.
	Sentence reports: *(pre)* Responded correctly to a number of the receptive vocabulary items, but probably needs further instruction and practice. *(post)* Generally competent in receptive vocabulary skills but may need additional help with nouns and verbs.				
					CIRCUS 8: HOW WORDS WORK
107	6-1	15	18	(pre) (post)	14% scored in range, 9% below. 76% scored in range, 16% below.
	Sentence reports: *(pre)* Probably needs further instruction and practice in all aspects of receptive functional language assessed by CIRCUS 8. *(post)* Generally competent in discriminating between verb forms, but probably needs further instruction and practice in discriminating between statements involving prepositions/negation/conjunctions and between sentences with different structures.				
					CIRCUS 2: HOW MUCH AND HOW MANY
107	6-1	16	37	(pre) (post)	3% scored in range, 0% below. 17% scored in range, 83% below.
	Sentence reports: *(pre)* Appears to lack quantitative competence or had difficulty coping with test tasks. Probably needs further instruction. *(post)* Very competent in quantitative skills and understandings.				
					CIRCUS 5: FINDING LETTERS AND NUMBERS
107	6-1	6	18	(pre) (post)	18% scored in range, 1% below. 58% scored in range, 58% below.
	Sentence reports: *(pre)* Appears to lack competence in recognizing letters and numbers. Probably needs further instruction and practice. *(post)* Generally competent in recognizing letters and numbers.				

In addition, we conducted attrition studies to determine whether performance changes established by longitudinal analyses should be attributed to the ICTS intervention or rather should be attributed to selective disenrollment in the project. That is, it is not unlikely that the students who leave school are those faring worst; consequently it was important to determine, with respect to this project, whether improved school performance over time should be explained in part by high attrition among the less successful. For this purpose, subjects were divided into two subsamples: those for whom two or more participation years of data were available, the "participation group" (N = 12); and those who had participated for only one year, the "attrition group" (N = 9). All outcomes investigated longitudinally were also examined in between-group (participant versus attrition group) analyses of variance where change from pre- to post-measurement in the first participation year served as a repeated factor. Of primary interest for exploring the influence of attrition is the interaction of group with pre-post change, significant effects suggesting differences in the ways those who remained and those who left experienced the intervention. Of incidental interest are main effects for group and significant cell contrasts between groups at each time of measurement. This procedure was used to study attrition throughout this report.

The longitudinal investigations described in this section use both change from pre- to post-assessment and participation year (I, II) as repeated factors in analyses of variance where CTBS reading and mathematics scores (both grade equivalents and distances from grade normal) provide dependent measures. Where appropriate, grade level

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to treat time as a single repeated three- or four-level factor. Our choice of the former procedure rested on two considerations. First, the decision to include or not include a fall measure collected some four months after a spring measure with no school experience intervening raises several issues that this procedure avoids (e.g., Hammond, 1979); these issues are further confounded in the case of students who changed achievement test levels (Barker and Pelavin, 1976). Second, we thought that the chosen procedure would underscore for readers the fact that participation year represents different calendar years (and thus differing pre- and post-measurement times) for some students.

("lower," representing grades one through three; and "higher," representing grades four through six) is also treated as an independent (crossed) factor. Tables 3.11 and 3.12 present cell means ($N = 17$) and values of F with related significance levels for examined sources of variation in reading scores. (Three-way interaction terms are not tabled because they yielded only negligible F values.) Scores in Table 3.11 represent grade equivalents. (Because tests are scored in terms of grade equivalents, grade level could not be used as an independent factor in this analysis without creating a very strong but meaningless main effect.) As the analysis summary indicates, there was a highly significant main effect for pre-post change ($p < .01$), a result anticipated on the basis of within-year findings. The average gain in grade equivalents for reading was 4.7 months in Participation Year I and 1 year 6 months in Participation Year II, or an average gain of 1 year 2.2 months in reading equivalents per year among two-year students. While participation year itself yields no main effect, the change-by-year interaction term is significant ($.05 < p < .10$); reading gains are substantially greater in a student's second year of participation, which corroborates within-year conclusions.

Dependent measures in Table 3.12 represent distance of obtained scores from grade normal scores expressed in months, where minus signs indicate that achievement is below expected levels. Except for the addition of grade level as an appropriate independent factor in this analysis, these scores are treated like those in Table 3.11. However, here no source of variation significantly influences results. It is interesting to note that while lower-level students' scores tend to be less distant from grade normal (in part reflecting floor effects), it is the higher level students whose scores show a net decrease in distance from grade normal over two participation years. These findings do not support the conclusion drawn on the basis of within-year comparisons that older students' scores are significantly more discrepant with grade norms than are younger students' scores, an effect that apparently does not hold up on a longitudinal basis. Finally, it should be noted that while no statistically significant difference between obtained and grade-normal reading scores remains at the

Table 3.11

CTBS READING SCORES
(grade equivalents)

Change	Participation Year I	Participation Year II
Pre	3.2	3.4
Post	3.7	5.0

Source	F	p
Participation Year	.91	n.s.
Change	14.29	.002
Year X Change	4.05	.06

termination of the project and while subjects are gaining at the rate of better than one year's performance equivalent per year, closing the discrepancy completely is a long-term goal that can be met only if students make far better than average expected progress consistently over several years.

Comparable findings come from the analyses of mathematics scores, as seen in Tables 3.13 and 3.14 (N = 17). The information presented in these tables for mathematics is organized like that presented in Tables 3.11 and 3.12 for reading. That is, Table 3.13 gives results of a two-way repeated measures analysis of variance on obtained grade equivalents, while Table 3.14 shows findings from a three-way analysis of variance on discrepancies between obtained and grade-normal scores. As Table 3.13 indicates, mathematics scores, like reading scores, exhibit strong main effects for pre-to-post change across two participation years. Average gain in grade equivalents in mathematics was 6.8 months in the first participation year and 1 year 1 month in the second, for an average nine-month gain per 10-month school year.

Table 3.12

DISTANCE BETWEEN OBTAINED AND
GRADE NORMAL READING SCORES

Participation Year

Change	I: Grade Level		II: Grade Level	
	Lower	Higher	Lower	Higher
Pre	-0.2	-2.0	-0.4	-2.1
Post	-0.8	-2.2	-1.0	-1.1

Source	F	p
Participation Year	.01	n.s.
Change	.12	n.s.
Grade Level	.64	n.s.
Year X Change	.61	n.s.
Year X Grade	.06	n.s.
Change	1.62	n.s.

Although the rate of gain is again greater in the second participation year, the change-by-year interaction term does not reach statistical significance in this analysis. This pattern of the outcomes is consistent with findings within year, suggesting that mathematics is initially less difficult than reading for partially sighted students who have not learned visual scanning techniques.

Outcomes of the analysis of distances between obtained and grade-normal scores in mathematics (Table 3.14) are instructively compared with the analysis of reading score discrepancies (Table 3.12). In both instances the independent factors produce no significant effects. Of particular interest, however, is the similar pattern of mean discrepancies in relation to grade level. That is, while grade level does

Table 3.13

CTBS MATHEMATICS SCORES
(grade equivalents)

Change	Participation Year I	Participation Year II
Pre	3.2	3.7
Post	3.9	4.8

Source	F	p
Participation Year	1.15	n.s.
Change	19.87	< .001
Year X Change	1.14	n.s.

not yield a main effect, the average discrepancy tends to be smaller for younger than for older students, while older students show more systematic decreases in discrepancy during the two years. But distance scores for younger students are substantially smaller in mathematics than in reading both initially and over time, the discrepancy reducing to zero at the end of the second participation year. We suggest that visual scanning may be especially difficult for younger partially sighted students; thus, while the ICTS successfully assists them in overcoming initial relatively small deficits in mathematics achievement, the process of overcoming small initial deficits in reading achievement is more difficult. However, comparing the size of the post-test reading discrepancy for younger students in the second participation year ($\bar{x}$ = 1 year) with the pre-test reading discrepancy for older students in the first participation year ($\bar{x}$ = 2 years)--groups whose grade levels are reasonably comparable--suggests that early ICTS intervention helps prevent severe reading deficits, leaving smaller discrepancies that can be overcome with less difficulty as visual scanning skills advance. Finally, it should be recalled that

Table 3.14

DISTANCE BETWEEN OBTAINED AND
GRADE NORMAL MATHEMATICS SCORES

Participation Year

Change	I Grade Level Lower	I Grade Level Higher	II Grade Level Lower	II Grade Level Higher
Pre	-0.05	-2.0	-0.6	-1.8
Post	-0.6	-1.9	0	-1.5

Source	*F*	*p*
Participation Year	.01	n.s.
Change	.04	n.s.
Grade Level	1.40	n.s.
Year X Change	1.79	n.s.
Year X Grade	.01	n.s.
Change X Grade	.15	n.s.

in mathematics, as in reading, by the end of the project there remained no statistically significant differences between obtained and grade-normal scores.

Attrition studies of reading and mathematics scores indicated that sustained academic advances could not be attributed to selective dropout. In each outcome area, analyses yielded overall rates of change comparable to those provided by the longitudinal study and failed to yield either main effects or significant cell contrasts by group. However, the change-by-group interaction term approached significance in both reading ($F = 4.03$, $p = .07$) and mathematics ($F = 2.86$, $p = .12$); interestingly, it was the attrition group that tended to improve more rapidly during the first participation year. Consequently, the pattern of gains established in longitudinal analyses, if it is biased, most likely overrepresents slower learners.

CONCLUSIONS

In the area of academic achievement, we found significant improvement in both reading and mathematics in all three project years. In the first year, students showed more dramatic improvement in mathematics than in reading; in the second year, reading scores increased markedly, so that no substantial differences remained between reading and mathematics achievement; and by the end of the third year, students had made such large substantial gains in both areas that the differences between their scores and grade normal were not statistically significant in either reading or mathematics.

We believe these results reflect that, for visually impaired students, learning to perform computations is initially less difficult than reading because it requires less scanning. Thus, mathematics gains were greater until a second year of ICTS experience enabled students to learn the visual scanning skills needed for advances in reading achievement. Then, in the third year, students were able to make progress exceeding the normal rate of advance for fully sighted students, until they had virtually closed the gap between obtained and grade-normal scores. It is particularly noteworthy that Killian ICTS students are now closer to grade normal, on the average, than are most fully sighted students of similar socioeconomic status.

Our longitudinal analyses corroborated the within-year finding that mathematics gains preceded reading gains. However, although in both within-year and longitudinal analyses, younger students' scores initially tended to be closer to grade normal than did older students' scores, the longitudinal analyses showed that older students' scores moved more systematically toward grade normal during two years of ICTS participation. The longitudinal analyses also suggested that visual scanning may be especially difficult for younger students, so that overcoming small deficits in reading achievement takes them more time than overcoming small deficits in mathematics achievement. Longitudinal results, like within-year results, indicated that early ICTS intervention is probably helpful in preventing severe academic deficits related to visual impairment.

Attrition studies of both reading and mathematics scores showed that sustained improvement could not be attributed to selective drop-out. On the contrary, if there is any bias in the longitudinal analyses, the sample most probably overrepresents slower learners.

Consequently, it is reasonable to believe that ICTS exposure has a strong positive effect on partially sighted students' academic achievement, and that the longer the exposure, the greater the students' academic progress. Closing the gap between partially and normally sighted students' achievement scores is a long process that requires partially sighted students to gain at the rate of better than one year's progress per year, over a several-year period. However, with the use of ICTS, such a rate of progress does not seem to be an unreasonable goal.

IV. ACHIEVEMENT-RELATED VISUAL SKILLS

A second important evaluation objective was to track subjects' progress in visually dependent skill areas, including visual-motor integration and visual memory. We hypothesized that these phenomena would be implicated in information encoding, processing, and decoding for visually mediated learning activities and consequently that these phenomena would be closely related to academic achievement for partially sighted ICTS students. We used three measures to assess visually dependent skills: the Developmental Test of Visual-Motor Integration (VMI, Follett Education Corporation, reviewed in Buros, 1972), a visual associative memory subtest of the CIRCUS battery (CIRCUS 12: *See and Remember*), and a visual sequential memory subtest of the Illinois Test of Psycholinguistic Abilities (ITPA, reviewed in Buros, 1972).

The VMI consists of a series of increasingly complex geometric figures that students are asked to look at and copy. No test of memory, but only of integration of perceptual and motor performance, is involved. Classroom teachers at both sites administered the VMI to all subjects using standard instructions; scoring was provided by the school psychologists.

Our original plan was to pre- and post-test visual memory only during the first project year using CIRCUS 12. Because the subjects would have had little prior experience with visually mediated learning, we had supposed that in the fall their scores would resemble those of younger, normally sighted students (those just entering school); however, we expected that, with practice, spring scores would show substantial improvement in visual associative memory if visual information processing among partially sighted students is basically similar to such processing in normally sighted students. CIRCUS 12 was administered in fall 1974 (prior to the start of project funding) and in spring 1975 to Madison students (n = 4). Within this small data set, our expectations were borne out. As Table 4.1 shows, all students who had room for improvement on the basis of the pre-test (one student scored at ceiling) made substantial fall-to-spring gains. By the

Table 4.1

CIRCUS 12: SEE AND REMEMBER SCORES,
SITE I, 1974-1975

Subject	Post-test	Pre-test	Pre-Post Change
101	19	15	+4
102	18	14	+4
103	20	17	+3
104	19	20	-1

Range 0-20

end of an academic year's experience with the ICTS, Madison students were excelling 58 percent of normally sighted kindergarteners in visual and associative memory. It therefore seemed clear that if we were to continue measuring in this visual skill area, we needed to select a test with a greater upward range. Further, location of errors on the CIRCUS test suggested that stimulus items in a more difficult test should be graded in complexity and should involve sequential aspects (given equal complexity of CIRCUS stimulus arrays, recognition memory was superior for items occurring earlier rather than later in a left-right sequence). Such an instrument would potentially allow us to explore the relationship between memory for complex sequences of visually presented items and reading achievement (an area in which we had reason to think that ability simply to scan was critical for partially sighted students).

For these reasons, we administered the ITPA visual sequential memory subtest on a pilot basis to all Killian students in fall 1975. While the ITPA appeared to test more adequately the role of complexity and sequence in visual memory, it differed from the CIRCUS test in respects whose impact was difficult to judge: (1) the ITPA does not involve associative memory, so that no names are associated with visual stimuli in any items; (2) it employs geometric shapes rather than more recognizable and

codable items such as cartoon animals; (3) it requires reproduction rather than just recognition of the correct sequence. These considerations led us to hypothesize that while the ITPA was a difficult test, the problems it posed for subjects might not be appropriate for representing and measuring the kinds of visual information processes required for effective ICTS use to enhance academic achievement. For comparison purposes, we administered the CIRCUS 12 test to younger Killian students as well. In spring 1976 the ITPA was administered to all students at both sites (n = 13); a subset of these students (the younger Killian students and the Madison students) also received the CIRCUS test. The results, which will be presented and discussed later in this section, showed that although CIRCUS 12 and ITPA measure different aspects of visual memory, they both tap achievement-related features of visual information processing.

In 1976-1977, all subjects took the ITPA, and a subset of them (newly entering young subjects and older subjects who had not reached ceiling) also received CIRCUS 12. Because most students topped out on CIRCUS 12, only the ITPA was used for testing visual memory in 1977-1978.

VMI AND ITPA RESULTS

Year One Results

Table 4.2 shows VMI and ITPA data for 1975-1976. After subject identifier and age in years and months, the first four columns present VMI scores represented as age equivalents in years and months. Post-test scores appear first, followed by their distance from age normal; pre-test scores are then given, the last column indicating the pre-to-post gain or loss. A Wilcoxen matched-pairs signed-ranks test established that a substantial improvement in visual motor integration had occurred ($T = 6$, $p < .005$) among subjects in both sites. Although subjects in the two sites did not differ with respect to amount of improvement over the academic year,

Table 4.2

VISUALLY DEPENDENT SKILLS, 1975-1976

Subject	Age (Years-months)	VMI				ITPA[a]				Post-test: VMI-ITPA
		Post-test Score	Distance from Age Normal	Pre-test Score	Pre-Post Change	Post-test Score	Distance from Age Normal	Pre-test Score	Pre-Post Change	
Site I										
101	11-7	8-8	-35	7-2	+18	5-4	-75			+40
102	11-3	6-10	-53	6-10	0	5-7	-68			+15
103	9-2	7-10	-16	6-5	+17	10-5[b]	+15			-31
104	9-10	10-11	+13	7-10	+37	10-5[b]	+ 7			+ 6
105	6-8	5-7	-13	5-0	+ 7	6-10	+ 2			-15
Site II										
201	8-6	6-10	-20	5-10	+12	6-6	-24	8-4	-22	+ 4
203	12-4	9-6	-34	5-6	+48	6-6	-70	7-10	-16	+36
204	6-10	4-1	-33	4-9	- 8	5-7	-15	4-4	+15	-18
205	6-7	7-4	+9	6-5	+11	6-2	- 5	6-2	0	+14
206	6-1	4-9	-16	4-6	+ 3	10-5[b]	+52	4-10	+67	+68
207	5-5	5-3	-2	4-4	+11	5-7	+ 2	6-2	- 7	- 4
208	5-8	4-9	-11	4-4	+ 5	4-10	-10	3-1	+21	- 1
210	11-9	7-10	-47	7-4	+ 6	5-10	-.71	5-7	+ 3	+24
Means			-20		+13		-20		+ 8	

[a]ITPA was not administered to Madison subjects in fall 1976.

[b]Ceiling scores.

Madison subjects' outcomes were significantly higher than outcomes for Killian subjects as determined by a Mann-Whitney U test ($U = 10$, $\underline{p} < .085$). Because this post-test difference cannot be attributed to age (both the youngest and the oldest subjects are in the Killian classroom, so that age is not a variable that statistically discriminates sites), we think it should be attributed to more extensive ICTS experience.

Visual memory assessments are represented by the next two sections of Table 4.2. First are ITPA scores, again given in age equivalents and organized like the VMI data. While overall change data are not available, scores from the Killian site ($n = 8$) were examined on a pre-post basis using the Wilcoxen T test. This analysis did not indicate a statistically significant improvement in visual sequential memory during the school year as measured by the ITPA. Nor did a Mann-Whitney U test establish any between-site differences in visual memory outcomes at post-measurement despite the Madison subjects' greater previous practice in visual information processing.

The last column in Table 4.2 subtracts ITPA scores from VMI scores to determine whether (as we had hypothesized) the ITPA is more difficult; here positive numbers indicate superior performance on the VMI. First we examined the relationship between age-normal and obtained VMI scores using a Wilcoxen T test. This analysis established that ICTS subjects in both sites were performing below the level of their normally sighted age mates ($T = 6$, $p < .005$). The same analysis showed a similar but weaker relationship between age normal and obtained ITPA scores. That is, ITPA scores also tended to fall below age normal ($T = 21.5$, $p < .10$); but while the range of negative deviation is greater, the number of positive scores is also greater than for VMI scores. Finally, the VMI-ITPA relationship was similarly examined by means of a Wilcoxen T test. The results were nonsignificant ($T = 41$), suggesting that there is not a directional bias in the relationship between ITPA and VMI scores; that is, subjects' performance on the ITPA was not either systematically inferior or systematically superior to their VMI performance. We were thus obliged to reject the hypothesis that the ITPA is more difficult for partially sighted students.

CIRCUS 12, *See and Remember*, is the visual memory test originally chosen for the evaluation. Table 4.3 presents post-test, pre-test, and change scores on this measure for 10 subjects. (Range of possible scores is 0 to 20; no age or grade equivalent scales are available for this test.) Here change data also failed to yield statistically significant results, presumably because so many subjects were near or at ceiling. Post-test scores on CIRCUS 12 do differentiate sites, with Madison subjects exhibiting superior performance as indicated by a Mann-Whitney U test ($U = 1$, $p < .008$). This difference is, however, partially a function of age, since the oldest Killian subjects were ineligible for CIRCUS 12. Interestingly, CIRCUS 12 visual memory scores correlated more closely with visual motor integration (rho = .92, $p < .01$) than with ITPA visual sequential memory scores (rho = .48, $p \cong .10$).

Table 4.3

CIRCUS 12 SCORES, 1975-1976

Subject[a]	Post-test Score	Pre-test Score	Pre-Post Change
Site I			
101	19	19	0
102	16	18	-2
103	20	20	0
104	20	19	+1
105	19	19	0
Site II			
204	10	12	-2
205	17	17	0
206	13	15	-2
207	15	11	+4
208	13	11	+2

[a]CIRCUS 12 was administered to Madison subjects and only to Killian students who received the CIRCUS achievement battery.

Last, we undertook to investigate the association between these visually dependent skills and reading and mathematics achievement (Table 4.4). For this purpose, we employed the following sorts of derived achievement measures. To control for age differences, each subject's basic skill achievement at post-test time was represented by the distance between the CTBS reading and mathematics scores and the grade normal (see Table 3.1); similarly, each subject's visual skills were represented by the distance between the VMI and ITPA scores and the age normal score (see Table 4.2). A Spearman rank correlation (n = 9) established an extremely strong association between overall CTBS achievement and visual motor integration (rho average = .95, $p < .01$). A similar but weaker correlation linked overall achievement with ITPA visual memory scores (rho average = .68, $p < .05$). Because so few subjects took both CIRCUS 12 and CTBS, we were unable to examine the association of these two tests; however, the high correlation between CIRCUS 12 and VMI suggests that, if the latter is strongly related to achievement, so must the former be. We concluded, then, that both visual motor integration and visual memory are importantly related to partially sighted students' achievement.

Table 4.4

RANK CORRELATIONS AMONG ACHIEVEMENT
AND VISUAL SKILLS, 1975-1976 (n = 9)

	VMI	ITPA	Reading	Mathematics
VMI	...	.64	.98[a]	.92[a]
ITPA		...	.68	.68
Reading			...	.86[a]
Mathematics				

NOTE: All values are statistically significant.

[a]Indicates $p < .01$.

Year Two Results

Table 4.5 represents 1976-1977 outcomes for visual sequential memory (measured by that subtest of the ITPA) and visual motor integration (measured by the VMI). For purposes of comparison with age developmental scores, the table first presents subjects' chronological ages at post-test. Next are four columns representing VMI data. The first of these columns gives the post-test score in year-month equivalents, followed by the distance from post-test to age-normal scores. Next are presented pre-test scores and pre-to-post differences, both of which are also given in terms of age-equivalents. ITPA data are organized similarly in the last four columns of the table.

Visually related skill scores were examined using a Wilcoxen matched-pairs signed-ranks test as before (but here n = 14, since subjects below and within the age range of the CTBS are both appropriately tested with the VMI and ITPA). An examination of VMI pre-post differences revealed that, while a preponderance of the scores were positive, the gain was not statistically significant ($T = 24$, p = n.s.). This result contrasted with data for the preceding year, which showed significant improvements in visual motor integration. Exactly the reverse set of comparisons came from an examination of ITPA scores. Data from the second year showed a substantial improvement from fall to spring ($T = 11.5$, $p < .05$); however, data from the first year did not reveal even approximately systematic gains. Overall, by spring 1977, subjects continued to score below age norms on the VMI ($T = 7$, $p < .01$), while they had closed the gap between them and their age mates on the ITPA ($T = 26.5$, p = n.s.).

The investigation of visually relevant skill scores, like the achievement study, suggested an interesting pattern of results. We suspected that during the first year of intervention, students' visual motor coordination had increased as they learned to use the ICTS for academic tasks. Because ciphering, unlike reading, requires eye-hand

Table 4.5

VISUALLY DEPENDENT SKILLS, 1976-1977

Subject	Age (Years-months)	VMI Post-test Score	VMI Distance from Age Normal	VMI Pre-test Score	VMI Pre-Post Change	ITPA Post-test Score	ITPA Distance from Age Normal	ITPA Pre-test Score	ITPA Pre-Post Change
Site I									
102	12-3	8-7	-44	6-10	+21	5-10	-77	5-7	+ 3
103	10-2	6-5	-45	7-10	-17	10-5	+ 3	10-5+[a]	0
104	10-10	11-9	+11	10-11	+10	10-5+[a]	0	10-5+[a]	0
Site II									
201	9-6	9-6	0	6-7	+35	9-6	+ 3	7-3	+30
203	13-4	7-11	-65	7-4	+ 7	6-10	-66	7-10	-12
204	7-10	4-9	-37	4-4	+ 5	6-2	-20	5-7	+ 7
207	6-5	5-3	-14	5-3	0	10-5	+48	6-2	+51
208	6-8	6-10	+ 2	5-7	+15	6-2	- 6	4-4	+22
210	12-9	9-4	-41	6-5	+35	7-10	-47	7-3	+ 7
211	7-2	5-0	-26	4-4	+ 8	5-10	-16	4-7	+15
212	6-10	5-0	-22	4-9	+ 3	6-6	- 4	5-7	+11
213	9-10	9-6	- 4	6-7	+35	10-5+	+ 7	6-10	+43
214	8-3	5-0	-39	5-7	- 7	5-10	-29	6-6	- 8
215	11-8	6-10	-58	8-7	-21	10-5+[a]	0	9-9	+ 8
Means			-27		+ 9		-15		+13

[a]Ceiling score.

integration but not scanning, it is not entirely surprising that the first set of short-term outcomes showed gains in both mathematics achievement and VMI scores. As students continued to have academic experiences mediated by the ICTS, their scanning ability improved; at the same time, noticeable gains appeared in reading achievement and in visual sequential memory. These latter outcomes appeared to represent mastery of more difficult performance sequences for partially sighted students; intercorrelations among achievement scores and visually dependent skill outcomes, shown in Table 4.6, lend some support to this hypothesis.

Table 4.6

RANK CORRELATIONS AMONG ACHIEVEMENT AND VISUAL SKILLS, 1976-1977[a]
(n = 10)

	VMI	ITPA	Reading	Mathematics
VMI	--	.46	.66	.58
ITPA		--	.89[b]	.78[b]
Reading			--	
Mathematics				

[a]All values above .56 are statistically significant.

[b]Indicates $p < .01$.

As the pattern of correlations suggests, visual sequential memory is much more closely correlated with reading achievement than with mathematics achievement; and both reading achievement and ITPA scores showed most increase during the second year of intervention. We suspect this is because both reading and ITPA tasks involve visual scanning of a sort that is not required for performing mathematics or VMI tasks as well as visual motor coordination, which is a necessary condition for performing all of them; but the latter sorts of tasks showed significant improvement even during the first year of ICTS-mediated learning. Interestingly, despite the established general association

of mathematics and reading achievement (observed in our data as well), for these partially sighted students ITPA scores in the second project year are better predictors of reading outcomes than are mathematics scores obtained from the same achievement test.

Table 4.7 presents post-test and pre-test scores along with pre-to-post changes for younger subjects on CIRCUS 12, the test of visual associative memory. Newly entering young subjects and older subjects who had not yet reached ceiling on this measure were tested ($n = 6$). A Wilcoxen T test indicated that subjects' scores were significantly higher in spring 1977 than in fall 1976 ($T = 0$, $p < .01$). This result is of interest since the previous year's data failed to show significant improvement in CIRCUS 12 scores despite a larger N. We had hypothesized that the lack of effect reflected the circumstance that scores were too near ceiling rather than lack of advance in visual associative memory. This hypothesis receives some support by the 1976-1977 CIRCUS 12 data, where subjects initially well below ceiling showed substantial gains. Comparing these outcomes with patterns of results described above for older students, it seems likely that younger subjects entering the project in the second year were mastering skills involved in recognizing and reproducing symbols. That is, they were advancing in prequantitative ability (see CIRCUS 2, 5) because this skill area does not require scanning and sequential memory; rather it relies more on recognition memory and visual-motor integration.

Table 4.7

CIRCUS 12 SCORES, 1976-1977

Subject	Post-test Score	Pre-test Score	Pre-Post Change
204	10	10	0
207	18	15	+3
208	13	13	0
211	16	9	+7
212	17	11	+6
214	20	19	+1

Year Three Results

Table 4.8 presents 1977-1978 visual skills data in the following way. First subjects' ages at post-test are given, followed by the VMI post-test score and its distance from the age normal score; next are subjects' pre-test scores, followed by the pre-to-post change. ITPA data in Table 4.7 are organized in exactly the same way.

Visually related skill scores were examined using a Wilcoxen matched-pairs signed-ranks test as before; however, here $n = 13$, since subjects below the CTBS range are within the range of the VMI and ITPA. Pre-to-post changes in VMI scores yielded a value of $\underline{t} = 11$, $p < .02$. This significant gain is similar to the gain evidenced in first year project data and is stronger than performance improvements recorded in the second year. (It should be recalled that while a preponderance of subjects showed VMI improvements in the second year, those gains did not reach statistical significance.) The ITPA scores, in contrast, showed no significant change from fall 1977 to spring 1978. However, an examination of scores suggests that ceiling effects left little room for improvement; at pre-test, seven of the thirteen subjects attained the highest possible score in the ITPA range (10-5), and an eighth, while not at ceiling, scored above the age norm. Thus, while ITPA data showed significant gains only in the second year of the ICTS demonstration, it would be an error to conclude that subjects' visual sequential memory development had suffered; at the end of the third project year there was no systematic difference between obtained and age-normal scores on the ITPA.

LONGITUDINAL ANALYSES

Longitudinal analyses were undertaken at the end of the project to investigate changes in achievement-related visual skills over time for all subjects for whom at least two years of outcome measures were available. As described in Sec. III, longitudinal analyses used both change within a year and participation year as repeated factors in analyses of variance. VMI and ITPA outcomes were examined in this way, with both age-equivalent scores and distance between obtained

Table 4.8

VISUALLY DEPENDENT SKILLS, 1977-1978

Subject	Age (Years months)	VMI Post-test Score	VMI Distance from Age Normal	VMI Pre-test Score	VMI Pre-Post Change	ITPA Post-test Score	ITPA Distance from Age Normal	ITPA Pre-test Score	ITPA Pre-Post Change
Site I									
103	11-2	9-4	-22	6-5	+35	10-5+[a]	0	10-5	0
104	11-10	12-8	+10	11-9	+11	10-5+[a]	0	10-5+[a]	0
107	6-1	4-9	-16	4-1	+ 8	3-4	-33	3-7	- 3
Site II									
201	10-6	11-1	+ 7	9-6	+19	10-5+	0	9-9	+ 8
204	8-10	5-7	-39	4-9	+10	5-10	-36	6-2	- 4
207	7-5	5-7	-22	5-3	+ 4	9-9	+29	10-5	- 8
208	7-8	7-4	- 4	6-10	+ 6	9-9	+25	6-2	+43
210	13-9	6-10	-83	9-4	-30	6-10	-83	7-10	-12
212	7-10	6-0	-22	5-0	+12	6-6	-16	6-6	0
213	10-10	9-6	-16	9-6	0	10-5[a]	0	10-5[a]	0
215	12-8	9-4	-40	6-10	+30	7-3	-65	10-5[a]	-38
216	9-11	6-7	-40	7-2	- 7	10-5[a]	+ 6	10-5	0
217	9-10	7-11	-23	9-6	-19	10-5[a]	+ 7	10-5[a]	0
Means			-24		+ 6		-13		(b)

[a]Ceiling score.

[b]The frequency of positive nonscoreable changes (i.e., changes beyond ceiling) renders mean change infeasible to calculate for the final project year.

and age-normal scores treated as dependent measures. For distance measures, age level (younger versus older) was treated as an independent factor in accord with the procedures established in Sec. III; however, here age rather than grade level served as the crossed independent factor, because visual skills tests were normed for chronological age rather than grade.

Tables 4.9 and 4.10 present cell means and values of F with related significance for independent factors expected to influence visual-motor integration ($n = 17$); scores in Table 4.9 represent age equivalents in months. The analysis summary indicates a highly significant main effect for overall pre-post change ($p < .001$), an encouraging result since fall-to-spring gains reached statistical significance during only two of the three project years. The average gain in month equivalents was 12.1 for Participation Year I and 14.2 for Participation Year II, or an average gain of 13.2 months in developmental equivalents per year in visual motor integration among two-year students. Neither participation year nor the interaction of rate with participation year importantly affected scores.

Dependent measures in Table 4.10 represent distance of obtained scores from age-normal scores in terms of months (negative numbers indicate that students were below expected developmental performance). These measures are treated the same as those in Table 4.9 except for the addition of age level as an independent factor. Here pre-to-post change approaches significance ($p < .10$), suggesting that students were making strong, stable progress toward developmentally normal performance in visual-motor integration. (It should be recalled that such an effect requires consistent annual gains exceeding expected annual gains for normally sighted students.) In addition, age level significantly influenced scores, with older students beginning and remaining much further behind developmental norms than younger students. Longitudinal analysis of VMI scores, then, supported conclusions drawn from within-year data: while students showed improvement across project years, measured both as gains in developmental months and as decreases in distance from age-normal visual-motor functioning, they were unable to eliminate the discrepancy between obtained

Table 4.9

VMI SCORES
(age equivalents in months)

Change	Participation Year I	Participation Year II
Pre	73.1	82.4
Post	85.2	96.6

Source	F	p
Participation Year	1.46	n.s.
Change	14.67	< .001
Year X Change	.09	n.s.

and developmentally expected scores, with older students being at the most severe disadvantage.

Contrasting findings come from the analyses of visual sequential memory scores, as evidenced in Tables 4.11 and 4.12 (n = 17). Table 4.11 presents results of a two-way repeated measures analysis of variance on ITPA scores given as age equivalents in months, while Table 4.12 shows findings from a three-way analysis of variance on discrepancies between obtained and age-normal scores. As Table 4.11 indicates, none of the examined sources of variation had a major effect on visual sequential memory. Participation year is the strongest independent factor and approaches statistical significance, suggesting that the second year of ICTS experience was important in promoting visual sequential skills. Outcomes at the end of the second participation year averaged 15.1 months higher than outcomes attained at posttest time 12 months earlier; these findings tend to corroborate interpretations of within-year studies (where only the second project year

Table 4.10

DISTANCE BETWEEN OBTAINED AND
AGE NORMAL VMI SCORES

	Participation Year I		Participation Year II	
	Age Level		Age Level	
Change	Lower	Higher	Lower	Higher
Pre	-17.0	-41.0	-20.6	-39.6
Post	-17.3	-30.5	-14.2	-31.9

Source	F	p
Participation Year	.00	n.s.
Change	2.98	.10
Grade Level	5.27	.03
Year X Change	.006	n.s.
Year X Age	.00	n.s.
Change X Age	.75	n.s.

produced significant gains) and are strengthened by results of the longitudinal investigation of reading and mathematics scores.

The examination of distances between obtained and age-normal scores is summarized in Table 4.12, where only one main effect is evident: older students' visual sequential memory performance was substantially more discrepant with developmental norms than was the performance of younger students ($p < .05$). The cell means suggest that largest long-term gains on age norms are found primarily among the younger students, with older students neither losing ground nor advancing. (That the discrepancy did not increase for older students should be regarded as

Table 4.11

ITPA SCORES
(age equivalents in months)

Change	Participation Year I	Participation Year II
Pre	76.67	92.17
Post	82.89	98.0

Source	F	p
Participation Year	2.36	.14
Change	1.69	n.s.
Year X Change	.002	n.s.

encouraging in itself, since prior to ICTS intervention the gap between their performance and developmental norms had shown regular growth.) Consequently, the fact that by the end of the project no significant differences existed between obtained and grade-normal scores was primarily a function of the scores of younger students. These results, together with the longitudinal analysis of VMI scores, suggest that it may be more difficult for students to overcome deficits in perceptual motor skills related to visual impairment than to overcome related achievement deficits. If so, it could be supposed that while perceptual motor skills surely facilitate transfer of academic information and while some level of skill acquisition is requisite for reading and mathematics achievement, age-normal perceptual motor function is not necessary to grade-normal achievement.

Attrition analyses of VMI and ITPA scores leave these conclusions unchanged. That is, inclusion of the attrition group corroborated an effect for pre-post change in VMI scores and the absence of such an effect in ITPA scores. In neither case did the influence of group or

Table 4.12

DISTANCE BETWEEN OBTAINED AND AGE NORMAL ITPA SCORES

	Participation Year I		Participation Year II	
Change	Age Level		Age Level	
	Lower	Higher	Lower	Higher
Pre	-6.8	-39.8	-13.2	-28.1
Post	-10.2	-37.3	-1.8	-40.9

Source	F	p
Participation Year	.08	n.s.
Change	.01	n.s.
Grade Level	6.31	.02
Year X Change	1.67	n.s.
Year X Age	.00	n.s.
Change X Age	1.67	n.s.

group-by-change interaction approach significance. Interpretation of project results in the area of perceptual-motor skills, then, does not involve selective attrition factors.

CONCLUSIONS

During the first project year, students showed significant gains in visual motor integration but not in visual sequential memory; in the second year, visual motor integration showed only slight improvement, while visual sequential memory evidenced significant gains; and in the third year, students once again improved substantially in visual motor integration but not in visual sequential memory. The lack of improvement in visual sequential memory in the third project year,

however, must be interpreted with caution, because ceiling effects left little room for improvement.

These results seem to indicate that visual sequential memory, like reading, requires more scanning skill than does visual motor integration (corresponding to mathematics), and thus requires a longer learning period. Once visual sequential memory begins to improve, however, it appears to progress steadily toward age-normal levels and/or test ceiling.

In the area of visual motor integration, longitudinal analyses indicated a highly significant overall pre-post change, with students making strong progress toward normal performance. However, students were unable to completely close the gap between obtained and developmentally expected scores, and older students began and remained much further behind developmental norms than younger students.

In longitudinal analyses of visual sequential memory scores, we found that only the second participation year produced substantial gains; this result tends to corroborate within-year findings. We also found that gains made with respect to age norms were primarily a function of younger students' scores; however, the very fact that older students' discrepancy from age norms did not increase is encouraging, since this discrepancy had grown yearly before ICTS experience.

Thus, longitudinal analysis of both visual motor integration and visual sequential memory suggests that students may find it more difficult to overcome perceptual motor deficits than to eliminate related achievement deficits. It seems that although some level of perceptual motor skill is needed for reading and mathematics, age-normal functioning is actually not necessary to grade-normal achievement. Attrition analyses left these conclusions unchanged.

V. PSYCHOSOCIAL ASSESSMENTS

A third objective of the ICTS study was to examine self and social attitudes thought to be important in the enhancement of school experience. While attitudes are more difficult to assess than either skills or behaviors, all recent education research emphasizes the consequential role of students' feelings about their work and about themselves in their subsequent academic performance.

Test anxiety is regarded as an important element in the class of attitude toward school-like tasks that can influence academic success. It is well established that the test-taking experience often contributes greatly to test scores and that the experience is more or less threatening in relation to children's internal needs and their expectations of good or bad outcomes as based on past performance. For the ICTS population, informal observation during the year before the study suggested that the test-taking experience had been associated with failure and anxiety. We expected that success experiences fostered by the ICTS would help change test-taking attitudes and thus improve test performance.

For this reason, we chose to administer on a pre-post basis the Inventory of Factors Affecting Test Performance (FATP), which accompanies the Stanford Binet Form L-M, modified by Jensen and Kohlberg (1966) to include items tapping rapport with the examiner. The inventory is a 14-item rating scale filled out by the teacher for each subject immediately after the subject has completed the first cognitive achievement subtest in a pre- or post-testing session.

To investigate self and social attitudes, we had originally intended to administer only the Self Observation Scales (SOS, National Testing Service, reviewed by Katzenmeyer and Stenner, 1975), a nationally normed verbal self-report measure. SOS scales were developed in response to the need to assess affective behavior in children by means of well-standardized, empirically validated, multidimensional measures.

The scales load on four factors representing self-acceptance, social maturity, school affiliation, and self-security. The test, administered by the classroom teacher, is scored by the manufacturer, and results are reported as standard scores (T scores) for each subtest. We pretested the SOS on four Madison students in fall 1974 (prior to the granting period) and again in spring 1975. Because the spring 1975 data returned to us by NTS seemed counterintuitive and conflicted with informal observations made by the classroom teacher, we decided to search for an alternative test of self and social attitudes. Our search led us to the Self Social Constructs Test (SSCT, ETS, reviewed in Walker, 1973). We selected this test, along with several others that were generally well reviewed (e.g., the Piers-Harris Children's Self Concept Scale, the Coopersmith Self Esteem Inventory, the Purdue Social Attitudes Scale), and asked the teachers involved in our project to evaluate them relative to our purposes and our subject population. The SSCT, a nonverbal instrument for mapping self and social perceptions, emerged as most face valid and received great support. We used it in addition to the SOS in all three years of the evaluation. The SSCT employs six major variables: self-esteem, social distance from significant others, attachment to peers, social interest, perceived inclusion, and perceived individuation.

Finally, in the third year of the study, we also examined facial affect encoding and decoding. We introduced this assessment on the assumption that social perception and communication are visually based skills that mediate interpersonal behavior for visually impaired students in somewhat the same way that visual symbolic capability mediates academic activity. If so, then to the extent that the ICTS could be used to facilitate affect encoding and decoding, it could be instrumental in interpersonal as well as cognitive development for partially sighted students.

To measure facial affect recognition, we employed a short version of the Interperson Perception Test (IPPT, Heussenstamm and Hoepfner, 1969), forms AA (adult stimulus faces) and AC (child stimulus faces). The IPPT presents a series of stimulus photographs; these are faces varied in ethnicity and representing a fairly broad range of affect.

The subject is asked to respond to the stimulus picture by selecting, from a row of four photographs of another person, another picture which shows the same feeling. Adaptation of IPPT photographic materials for ICTS administration was accomplished without difficulty. However, administration of the full item set (40 adult-face and 40 child-face items) took too long for subjects' comfort and exceeded their attention span as well. Further, even with contrast-enhanced photographs, some of the items involved fine discrimination which exceeded students' visual capabilities. For these reasons, the test was reduced to a total of 20 items, 10 each from the adult and child forms. Items were selected for inclusion by administering the test to normally sighted adults; stimulus faces were chosen when all respondents scored correctly, with the constraint that sex and ethnicity of figures in the stimulus photographs be distributed as in the original item set.

In addition to affect decoding, an attempt was made to explore affect encoding among the ICTS students at the Killian site. We were interested in whether partially sighted students were able to produce conventional facial signs of six socially important affective dimensions: fear, disgust, anger, happiness, sadness, and surprise. Based on the work of Ekman and Friesen (1975), an affect expression task was devised in which students had an opportunity to make each of these expressions twice, along with two neutral faces. The task was administered to 10 site II subjects along with matched normally sighted controls (students of the same age [$\pm$ 6 months] and sex chosen from regular classrooms). Students were photographed as each expression was elicited. Photographs were scored, using the multiple criteria provided by Ekman and Friesen to determine whether a student "had the expression."

FACTORS AFFECTING TEST PERFORMANCE

Year One

Table 5.1 presents 1975-1976 total post-test, pre-test, and change scores for all subjects in columns one through three. The last three columns single out for attention the combined scores on items 9 and 10 from the inventory.

Table 5.1

FACTORS AFFECTING TEST PERFORMANCE, 1975-1976

Subject	All Items			Items 9 and 10		
	Post-test Score	Pre-test Score	Pre-Post Change	Post-test Score	Pre-test Score	Pre-Post Change
Site I						
101	36	36	0	5	3	+2
102	27	26	+1	4	2	+2
103	26	25	+1	3	2	+1
104	32	33	-1	4	2	+2
105	32	27	+5	2	2	0
Site II						
201	31	31	0	2	4	-2
203	26	23	+3	2	2	0
204	16	25	-9	2	3	-1
205	27	31	-4	2	4	-2
206	23	26	-3	2	2	0
207	28	32	-4	2	3	-1
208	32	25	+7	4	3	+1
210	26	28	-2	2	3	-1
Means	28	28	-0.5	2.8	2.7	+0.08

A preliminary investigation of pre-test data had provided only a weak positive correlation between fall achievement test scores and FATP ratings. Looking more closely at the rating scales, we found six items on which there was virtually no variation. This circumstance led us to believe that the common history of our subjects as visually impaired students had generated a rather invariant response to the test-taking situation that would not be easy to overcome. Among these responses, some could be viewed as positive and not needing any change (e.g., "fear of adult" and "compliance with adult" were uniformly rated in a favorable manner).

Two scales, however, were uniformly assigned a negative rating ("sense of intellectual challenge" and "willingness to continue with test"); we therefore proposed to give special attention to outcomes on these items (9 and 10). We hoped to see some change in the sense of challenge and willingness to continue, and consequently to find a

changed relationship between these factors and achievement. Although the fall-to-spring change for the test as a whole was not statistically significant, substantial improvement on items 9 and 10 was evident among Site I subjects. To demonstrate this, because the range of scores was small, we recast the change data in binary form, asking simply whether the subject improved (received a positive change score) or not (received either a 0 or a negative score). A binomial test* then established that Madison subjects, in contrast with Killian subjects, showed significant positive change ($p = .03$). It was presumably this difference on items 9 and 10 which accounted for the fact that, by post-test time, Madison subjects were receiving total inventory scores systematically higher than scores received by Killian subjects (Mann-Whitney $U = 915$, $p < .085$) despite the absence of between-group differences in the fall. Finally, at post-testing an approximately significant positive correlation was established between actual achievement as measured by the CTBS and factors affecting test performance (rho = .43, $p \cong .10$).

<u>Year Two</u>

The FATP data collected during the 1976-1977 project year again failed to indicate significant overall change on any factor assessed by the rating scales. The distressing consistency in outcomes caused us to wonder whether they should be explained in terms of problems with the assessment method or in terms of real absence of change in attitudinal factors impinging on the test-taking situation. Regarding the method, a study of judgments for fall 1975 indicated that the ratings themselves seemed to be reliable; that is, for the site II classroom, two teachers and a Rand classroom observer rated ten students highly consistently and without apparent halo effects. Teachers commented that while some items seemed more applicable than others, the instrument as a whole touched factors that importantly described

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*Given data which can fall into two and only two discrete categories, the non-parametric binomial test is a method that can be used with small samples for determining whether the obtained values differ from those that would be expected by chance (Siegel, 1956, pp. 36-42).

the testing situation. Consequently, we regarded the instrument as a fairly good one. However, as we had noted in the previous year, many items continued to exhibit little variation over subjects. Subsequent to the collection of those data, subjects had received an additional year of ICTS experience and their test performance had improved markedly; however, they seemed still to face testing with basically unaltered attitudes. Perhaps the situation was best illustrated by one subject who gained at a rate of 1.8 grade equivalents in both reading and mathematics during year two as measured by the CTBS. Unmoved by his success, he drew a picture of a tombstone bearing his name and the inscription, "Died of testing 1977--Reincarnated when testing was over." Being able to write an inscription that would have greatly exceeded even his reading capability at the beginning of the school year apparently did not generate the sort of success experience that would override a long history of prior academic frustration. Because of the apparent stability of scores representing factors affecting test performance and their lack of association with obtained test scores, we decided to discontinue this assessment for year three.

SELF AND SOCIAL ATTITUDES

Year One

Two instruments, the Self Social Constructs Test (SSCT) and the Self Observation Scales (SOS), assessed self and social attitudes. The Self Social Constructs Test (see review in Walker, 1973) is a nonverbal instrument using spatial symbols and their arrangement to represent self and social schemata. For the purpose of this evaluation, we sought to assess six constructs by such schemata: self-esteem, social distance from significant others, scope of peer attachment, social interest, perceived inclusion, and perceived individuation. Table 5.2 presents 1975-1976 data regarding three self-social constructs: self-esteem, social distance (from peers and from teachers), and scope of peer attachment. In each case the post-test score appears, followed by the pre-test score and the fall-to-spring change. Data regarding social interest, perceived inclusion, and perceived individuation have been omitted. These constructs did not show significant

Table 5.2

SELF SOCIAL CONSTRUCTS TEST, 1975-1976

Subject	Self-Esteem			Social Distance from Students			Social Distance from Teachers			Attachment to Peers		
	Post-test Score	Pre-test Score	Pre-Post Change	Post-test Score	Pre-test Score	Pre-Post Change[a]	Post-test Score	Pre-test Score	Pre-Post Change[a]	Post-test Score	Pre-test Score	Pre-Post Change
Site I												
101	39	38	+ 1	2	7	-5	2	2	0	24	24	0
102	24	34	-10	7	10	-3	6	3	+ 3	23	18	+ 5
103	26	27	- 1	9	7	+2	12	4	+ 8	18	21	- 3
104	29	28	+ 1	2	5	-3	2	4	+ 2	24	24	0
105	20	23	- 3	8	6	+2	11	10	+ 1	21	23	- 2
Site II												
201	28	20	+ 8	10	4	+6	7	9	- 2	21	14	+ 7
203	39	27	+12	2	5	-3	2	8	- 6	19	5	+14
204	23	33	-10	6	2	+4	5	2	+ 3	2	13	-11
205	34	24	+10	7	2	+5	2	2	0	23	3	+20
206	27	37	-10	7	9	-2	6	7	- 1	7	15	- 8
207	34	32	+ 2	3	4	-1	12	2	+10	15	14	+ 1
208	22	23	- 1	2	6	-4	2	5	- 3	16	12	+ 4
210	45	29	+16	2	9	+7	12	10	+ 2	19	18	+ 1
Means	30	29	+ 1.2	5	6	+0.4	6	5	+ 1.3	18	16	+ 2.2
Range	(8-48)			(2-12)			(2-12)			(0-24)		

[a]Negative changes are representative of *decreased* social distance (i.e., favorable change).

differences either between fall and spring scores or between sites at either period. In part, such outcomes reflect the very small range of possible scores on these constructs (0 to 4 and 0 to 2); besides restricting the space for change, the limited range produces a great number of tied ranks that vitiate the effectiveness of ordinal statistics.

With respect to self-esteem, an overall examination of post-test outcomes in relation to pre-test scores revealed no systematic difference. However, the change scores on this construct suggested that Killian subjects experienced greater positive change in self-esteem than Madison subjects (Mann-Whitney $U = 11$, $p \cong .11$). Consequently, Killian subjects tended to obtain higher post-test scores, although this tendency was not statistically significant.

Neither social distance measure exhibited significant fall-to-spring changes overall. However, a between-site comparison indicated that Madison subjects, in contrast to Killian subjects, perceived

themselves as having become more distant from their teacher by post-test time (Fischer's exact test, $p = .10$). We attributed this difference to the circumstance that in the late spring the Madison class was being instructed by a substitute teacher, the regular teacher having been on leave during the end of the academic year.

The last measure in Table 5.2, attachment to peers, showed the following interesting pattern. At post-test time, scope of peer attachment was significantly broader among Madison than among Killian students (Mann-Whitney $U = 6$, $p < .03$). This result was expected, since Madison subjects had been part of an ICTS group for a longer period and, in fact, were near ceiling on this measure. But examining the change scores revealed that fall-to-spring increases occurred primarily among the Killian subjects, a trend that approximated statistical significance.

Outcomes for the remaining three dimensions assessed by the SSCT--social interest, perceived inclusion, and perceived individuation--were not readily amenable to similar comparisons; the very small range of possible scores on these constructs (0-4, 0-2, and 0-2 respectively) both restricts the space for change and produces a great number of tied ranks that limit the usefulness of ordinal statistics. Instead, these data were treated in terms of binomial tests of the probability of positive or negative change. No significant likelihood of change in either direction over the school year was established for either social interest or for perceived inclusion. However, with respect to perceived individuation, binomial tests indicated a significantly greater chance ($p < .01$) that students would either remain the same or else perceive themselves as more individuated rather than as more like the majority of students during the course of the school year.

The second attitude instrument employed, the SOS, was designed to assess psychosocial constructs thought to be related to school success (Katzenmeyer and Stenner, 1975). Table 5.3 presents pre- and post-test scores (T-scores) for each of four socioemotional dimensions tapped by the test (self-acceptance, social maturity, school affiliation, and self-security, in that order). Change scores represent fall-to-spring differences obtained in T scores.

Table 5.3

SELF-OBSERVATION SCALES, 1975-1976[a]

Subject	Self-Acceptance			Social Maturity			School Affiliation			Self-Security		
	Post-test Score	Pre-test Score	Pre-Post Change	Post-test Score	Pre-test Score	Pre-Post Change	Post-test Score	Pre-test Score	Pre-Post Change	Post-test Score	Pre-test Score	Pre-Post Change
Site I												
101	65	61	+ 1	53	54	- 1	59	58	+ 1	67	61	+ 6
102	54	60	- 6	54	50	+ 4	59	54	+ 5	46	55	- 9
103	56	63	- 7	55	56	- 1	55	58	- 3	65	66	- 1
104	65	64	+ 1	57	56	+ 1	59	58	+ 1	67	66	+ 1
105	64	48	+16	56	53	+ 3	57	33	+24	67	67	0
Site II												
201	57	52	+ 5	56	57	- 1	31	44	-13	63	59	+ 4
203	60	59	+ 1	58	60	- 2	61	59	+ 2	57	57	0
204	55	56	- 1	26	24	+ 2	52	56	- 4	25	22	+ 3
205	55	38	+17	55	49	+ 6	43	52	- 9	58	46	+12
206	43	41	+ 2	30	24	+ 6	55	43	+12	34	37	- 3
207	40	42	- 2	30	29	+ 1	28	41	-13	46	50	- 4
208	53	53	0	39	37	+ 2	46	60	-14	45	48	- 3
210	51	43	+ 8	51	41	+10	46	51	- 5	52	45	+ 7
Means	55	52	+ 2.7	48	45	+ 2.3	50	51	- 1.2	53	52	+ 1.0

[a]T-scores: scales are standardized with $\bar{x} = 50$ and s.d. = 10.

An examination of fall and spring scores across sites (using a Wilcoxen matched-pairs test) revealed slight change overall, an outcome consonant with conclusions drawn from the analysis of 1975-1976 Self Social Constructs Test data. Only social maturity scores indicated a significant gain ($p < .05$) during the school year, an outcome not specifically associated with the demonstration and probably reflective of normal social development with increasing school experience. Two SOS dimensions (self-acceptance and self-security) have some face relevance to self-esteem as measured by the SSCT. Both dimensions seemed to indicate that Killian subjects experienced greater positive change, although only the score difference on the self-security dimension was statistically significant (Mann-Whitney $U = 6.5$, $p < .05$). Such a difference in extent of change corroborated SSCT results. However, on both SOS dimensions, Madison students scored significantly higher at post-test (self-acceptance: $U = 6$, $p < .05$); (self-security: $U - 4.5$, $p \cong .01$). In contrast, the SSCT post-test data generated no significant between-site differences in self-esteem

scores, although Killian students appeared to score somewhat higher. These discrepancies between the two socioemotional assessments led us to explore their association. Using a Spearman rank correlation, a rho value = .04 characterized the relationship between self-esteem (SSCT) and self-acceptance (SOS), while self-esteem (SSCT) and self-security (SOS) correlated at .22; the average intercorrelation among these ostensibly similar constructs was .13. However, self-acceptance (SOS) and self-security (SOS) achieved a highly significant rho value of .81. We entertained the hypothesis that the two SOS self-attitude dimensions are related to one another in part because of verbal method bias, which operated in favor of older Madison subjects who were better readers. Because the SSCT is a nonverbal assessment, it minimizes both social desirability response biasing and dependence on reading skill.

The two socially oriented dimensions of the SOS, social maturity and school affiliation, were similarly investigated in relation to presumably relevant SSCT measures (scope of peer attachment, social distance from students, and social distance from the teacher). Both SOS social dimensions yielded significant or nearly significant differences on post-test scores favoring the Madison subjects (social maturity: $U = 11$, $p \cong .01$). A similarly significant difference between groups emerged at post-test on the SSCT measure of peer attachment. However, the SSCT peer attachment dimension showed an approximately significant rate of positive change favoring Killian subjects, a pre-post trend that did not appear in the SOS data. On the contrary, SOS data located a significant difference in positive change scores only among Madison subjects and only on the measure of school affiliation ($U = 7$, $p < .05$). This result was surprising in view of the fact that Madison subjects had a substitute teacher for the last month of school (the time at which these assessments were made) and SSCT measures of social distance indicated Madison students felt significantly less close to their relatively new teacher at the end of the year. Again, we investigated these discrepancies by exploring patterns of correlations among SOS and SSCT constructs. The SSCT peer attachment measure was significantly and positively associated with the SOS measure of

social maturity (rho = .66), and nearly attained a significant positive correlation with school affiliation (rho = .41). Social distance from students and teachers (SSCT) showed a negative relationship to school affiliation (SOS) as expected, but the correlation was not significant (rho average = -.29).

In many respects, then, the SOS and the SSCT provided somewhat corroborative assessments of similar psychosocial dimensions. However, the strength of the corroboration was not impressive, and was vitiated by instances in which the two instruments yielded discrepant conclusions. These discrepancies notwithstanding, both sets of results suggested students were gaining in self-esteem and advancing in peer relationships as well.

Year Two

Table 5.4 provides 1976-1977 post-test, pre-test, and change scores for the SSCT measures of self-esteem, social distance from students and teachers, and scope of peer attachment. Table 5.5 represents SOS post-test, pre-test, and change scores for the same year. In contrast to the first year's findings, the second year's data show that subjects' self-concepts had become substantially more positive. Using Wilcoxen matched-pairs signed-ranks tests, we examined the SSCT self-esteem scores and the SOS self-acceptance scores for pre-to-post changes; both yielded significant fall-spring increases ($T = 15$, $p < .05$ and $T = 6$, $p < .02$, respectively). Because the two instruments are not highly correlated with one another, we think the result is a trustworthy one and give it considerable importance. It is not surprising that a second year of ICTS experience would be required to influence the self-concept of visually impaired students.

Scope of peer attachment (SSCT) and school affiliation (SOS) formed another pair of dimensions examined for pre-post changes. In the 1976-1977 data, as in the previous year, both dimensions showed basically positive differences which did not reach statistical significance. While the distribution of subjects precluded between-site comparisons, the classrooms appeared to differ in essentially the same ways as before. That is, Madison subjects had higher peer attachment

Table 5.4

SELF SOCIAL CONSTRUCTS TEST, 1976-1977

Subject	Self-Esteem Post-test Score	Self-Esteem Pre-test Score	Self-Esteem Pre-Post Change	Social Distance from Students Post-test Score	Social Distance from Students Pre-test Score	Social Distance from Students Pre-Post Change[a]	Social Distance from Teachers Post-test Score	Social Distance from Teachers Pre-test Score	Social Distance from Teachers Pre-Post Change[a]	Attachment to Peers Post-test Score	Attachment to Peers Pre-test Score	Attachment to Peers Pre-Post Change
Site I												
102	29	26	+ 3	2	4	- 2	6	5	+ 1	17	19	- 2
103	33	24	+ 9	4	7	- 3	6	7	- 1	5	12	- 7
104	31	16	+15	9	2	+ 7	2	2	0	24	24	0
Site II												
201	44	32	+12	2	6	- 4	2	12	-10	9	16	- 7
203	29	30	- 1	2	2	0	2	2	0	24	21	+ 3
204	24	41	-17	5	2	+ 3	8	2	+ 6	3	2	+ 1
207	36	36	0	2	2	0	3	2	+ 1	19	22	- 3
208	34	26	+ 8	2	2	0	2	2	0	24	24	0
210	34	31	+ 3	12	12	0	2	12	-10	22	19	+ 3
211	36	28	+ 8	2	2	0	2	5	- 3	24	6	+18
212	22	20	+ 2	6	5	+ 1	5	10	- 5	3	4	- 1
213	40	31	+ 9	7	8	- 1	12	9	+ 3	24	21	+ 3
214	48	38	+10	2	2	0	2	12	-10	19	9	+10
215	42	27	+15	2	4	- 2	2	2	0	24	24	0
Means	34	29	+ 5.4	4	4	- 0.07	4	6	- 2.0	17	16	+ 1.3
Range	(8-48)			(2-12)			(2-12)			(0-24)		

[a]Negative changes are representative of *decreased* social distance (i.e., favorable change).

scores at pre-test (allowing little room for favorable change) and showed greater school affiliation. We attributed these differences to the first-generation site's longer duration as an ICTS classroom and to the related stability of the subjects as a peer group. Finally, as in the previous year, neither social distance measure exhibited significant overall change.

Remaining dimensions of the SSCT are not tabled because they yielded binary data resulting in a limited range of scores with little variance. For these reasons we could not make use of ordinal properties and instead approached the data in terms of binomial tests of the probability of positive or negative change over the school year. For such measures, we asked about the probability of positive change as opposed to the combined probability of negative change or no change; thus we also determined the probability of negative change as opposed

Table 5.5

SELF-OBSERVATION SCALES, 1976-1977[a]

Subject	Self-Acceptance Post-test Score	Self-Acceptance Pre-test Score	Self-Acceptance Pre-Post Change	Social Maturity Post-test Score	Social Maturity Pre-test Score	Social Maturity Pre-Post Change	School Affiliation Post-test Score	School Affiliation Pre-test Score	School Affiliation Pre-Post Change	Self-Security Post-test Score	Self-Security Pre-test Score	Self-Security Pre-Post Change
Site I												
102	60	54	+ 6	59	57	+ 2	60	56	+ 4	58	54	+ 4
103	62	43	+19	57	50	+ 7	43	30	+13	66	69	- 3
104	63	63	0	60	60	0	59	59	0	67	67	0
Site II												
201	58	58	0	51	52	- 1	24	30	- 6	70	71	- 1
203	59	61	- 2	58	48	+10	39	60	-21	55	50	+ 5
204	53	50	+ 3	44	24	+20	40	51	-11	55	30	+25
207	61	49	+12	38	38	0	32	46	-14	52	51	+ 1
208	55	56	- 1	24	27	- 3	51	47	+ 4	36	34	+ 2
210	60	54	+ 6	54	53	+ 1	43	27	+16	56	58	- 2
211	55	48	+ 7	33	28	+ 5	36	36	0	51	37	+14
212	58	49	+ 9	25	38	-13	38	43	- 5	47	60	-13
213	61	55	+ 6	56	54	+ 2	38	41	- 3	63	54	+ 9
214	57	56	+ 1	42	27	+15	50	56	- 6	53	52	+ 1
215	62	57	+ 5	59	49	+10	50	51	- 1	65	56	+ 9
Means	59	54	+ 5.1	47	44	+ 3.9	43	45	- 2.1	57	54	+ 3.6

[a]T-scores: scales are standardized with $\bar{x}$ = 50 and s.d. = 10.

to combined probability of negative change or no change. Pursuing this analytic strategy with social interest, perceived inclusion, and perceived individuation, we obtained the following results:

- There was no significant likelihood that social interest would increase or remain stable over the year; however, there was a strong probability ($p < .01$) that it would either remain the same or decline.
- For perceived group membership it was equally likely that scores would remain the same/increase or remain the same/decrease from fall to spring.
- With respect to perceived individuation, binomial tests suggested the likelihood ($p = .02$) that students would either remain the same or would perceive themselves as more individuated (more different from the majority) as the school year progressed.

The self-social attitude measures suggested that students were feeling better about themselves and were attached to the others in their own classroom. However, assessment of social interest, perceived group membership, and perceived individuation indicated that subjects nevertheless did not feel more integrated into major social structures. This latter finding probably reflected the subjects' awareness of their status as special education students.

Year Three

Table 5.6 gives 1977-1978 post-test and pre-test scores for four self and social constructs indexed by the SSCT, along with size and direction of change from fall to spring. Self-esteem, social distance, and scope of peer attachment scores were examined with Wilcoxen signed-ranks matched-pairs tests. The self-esteem measure showed no change from fall to spring; only second year project data showed significant gains on this measure. In contrast, the total social distance measure for the first time showed systematic decreases ($T = 16$, $p = .10$). It should be recalled that the SSCT separately assesses social distance from four significant others: mother, father, teacher, and peers. An exploration of these four types of items indicated that the decrease occurred, as predicted, primarily in the area of social distance from other students; for this construct the value of the pre-post $\underline{T} = 7$, $p < .05$. If decreasing social distance were manifest in home- as well as school-related constructs, the results would not readily be attributable to ICTS intervention. This result was paralleled by the tendency of scope of peer attachment scores to show systematic increases. As in the previous year, the peer attachment measure suggested that students' friendship circles were broadening. However, the value of the Wilcoxen $\underline{T}$ (16.5) failed to attain significance because of the proportion of zero change scores, in the main a reflection of the circumstance that many pre-test scores were at or near ceiling.

The remaining constructs (social interest, perceived inclusion, and perceived individuation) yielded binary scores that were investigated using binomial tests of the probability of positive or negative change over the school year. For social interest, a binomial test

Table 5.6

SELF SOCIAL CONSTRUCTS TEST, 1977-1978

	Self-Esteem			Social Distance from Students			Social Distance from Teachers			Attachment to Peers		
Subject	Post-test Score	Pre-test Score	Pre-Post Change	Post-test Score	Pre-test Score	Pre-Post Change[a]	Post-test Score	Pre-test Score	Pre-Post Change[a]	Post-test Score	Pre-test Score	Pre-Post Change
Site I												
103	27	30	- 3	5	5	0	8	8	0	10	19	- 9
104	27	28	- 1	2	2	0	2	2	0	22	12	+10
107	31	13	+18	2	4	- 2	2	8	- 6	15	12	+ 3
Site II												
201	28	43	-15	3	2	+ 1	7	6	+ 1	13	18	- 5
204	25	25	0	4	7	- 3	6	3	+ 3	3	3	0
207	43	48	- 5	12	7	+ 5	12	12	0	24	24	0
208	25	41	-16	2	2	0	2	2	0	24	24	0
210	32	28	+ 4	2	12	-10	12	12	0	24	24	0
212	23	33	-10	3	6	- 3	8	12	- 4	4	9	- 5
213	30	39	- 9	2	4	- 2	12	12	0	18	12	+ 6
215	22	30	- 8	2	7	- 5	2	2	0	21	24	- 3
216	35	26	+ 9	2	5	- 3	9	4	+ 5	21	21	0
217	28	17	+11	2	3	- 1	7	3	+ 4	12	13	- 1
Means	30	31	- 1.9	3	5	- 1.8	7	7	+ 0.2	16	16	- 0.3
Range	(0-48)			(2-12)			(2-12)			(0-24)		

[a]Negative changes are representative of *decreased* social distance (i.e., favorable change).

established a significant likelihood that scores on this measure would either remain the same or increase ($p = .046$). On the other hand, perceived group inclusion was likely either to remain the same or to decrease ($p = .011$) even though perceived individuation scores were also likely to remain the same or decrease ($p = .046$). As a whole, these outcomes suggest that while students are feeling closer to more of their peers and are perceiving themselves as less "different" from others, their interest in being integrated into major social structures is not in fact accompanied by a feeling of being more included; partially sighted ICTS students still seem to perceive themselves more as individuals than as similar to other students.

Table 5.7 shows SOS scores for 1977-1978. Among the four constructs assessed, only school affiliation shows a systematic pre-to-post change that approximates significance ($T = 19$, $.05 < p < .10$). The change, however, is in the direction of decreasing affiliation, a

Table 5.7

SELF-OBSERVATION SCALES, 1977-1978[a]

Subject	Self-Acceptance			Social Maturity			School Affiliation			Self-Security		
	Post-test Score	Pre-test Score	Pre-Post Change	Post-test Score	Pre-test Score	Pre-Post Change	Post-test Score	Pre-test Score	Pre-Post Change	Post-test Score	Pre-test Score	Pre-Post Change
Site I												
103	59	57	+ 2	57	54	+ 3	57	35	+22	68	68	0
104	63	60	+ 3	62	60	+ 2	53	53	0	67	67	0
107	46	63	-17	21	44	-23	33	49	-16	33	58	-25
Site II												
201	61	60	+ 1	64	64	0	57	57	0	64	62	+ 2
204	50	52	- 2	40	30	+10	55	54	+ 1	48	49	- 1
207	61	60	+ 1	54	54	0	52	55	- 3	62	61	+ 1
208	53	59	- 6	52	54	+ 2	55	60	- 5	61	59	+ 2
210	59	53	+ 6	61	63	- 2	54	53	+ 1	64	54	+10
212	54	53	+ 1	33	27	+ 6	31	41	-10	47	53	- 6
213	58	61	- 3	59	59	0	38	54	-16	52	67	-15
215	59	62	- 3	62	57	+ 5	54	60	- 6	57	61	- 4
216	60	55	+ 5	54	49	+ 5	40	28	+12	61	56	+ 5
217	52	49	+ 3	58	59	- 1	56	55	+ 1	36	46	-10
Means	56	57	- 0.7	52	52	+ 0.5	49	50	- 2.3	55	58	- 3.1

[a]T-scores: scales are standardized with $\bar{x}$ = 50 and s.d. = 10.

surprising result in view of the greater scope and intimacy of peer relationships evident in the SSCT data. While the remaining SOS scales all generated a preponderance of positive pre-post changes, none of these differences was statistically significant.

LONGITUDINAL ANALYSES

Longitudinal analyses explored the extent of systematic change along psychosocial dimensions over time for subjects for whom two years of outcome measures were available. For these investigations we selected only those constructs that seemed likely, on the basis of within-year studies, to show directional differences. From the test of self-social constructs, we examined self-esteem, social distance from students and teachers, and scope of peer affiliation (omitting the assessments amenable only to binary scoring). The four SOS scales--self-acceptance, social maturity, school affiliation, and self-security--were also investigated. Attitudinal measures of test-performance factors were excluded, since they had been collected only

during the first two project years. The eight psychosocial constructs chosen for longitudinal study were treated as dependent variables in repeated measures analyses of variance, where participation year and rate of change within year constituted the repeated factors; grade level was an additional nonrepeated independent factor. (Grade level rather than age was employed because the norming sample for the SOS was drawn on the basis of school grade; it should be noted, however, that comparisons between grade and age as independent factors in the analyses showed differences to be very slight.) The discussion of results first considers self-oriented dimensions and then social dimensions (N = 24).

Self-Oriented Dimensions

Tables 5.8, 5.9, and 5.10 present cell means and values of F with related significance levels for sources of variation in self-esteem (SSCT), self-acceptance (SOS), and self-security (SOS). Since SOS scales yield standardized T scores, means in Tables 5.9 and 5.10 can be instructively compared; but since SSCT scores are not standardized, only the pattern of outcomes in Table 5.8 is of interest. Whereas none of the independent factors examined had a strong impact on self-esteem (Table 5.8), grade level appeared to make some contribution to outcomes ($p = .13$); in general, older students scored higher, a conclusion that is qualified by two important interactions. First, the older students are those who showed positive within-year changes ($p = .06$), and second, only in their first participation year did older students score higher than younger ones ($p = .02$). Outcomes, then, for the SSCT self-esteem measure are primarily characterized in terms of change-by-grade and year-by-grade interactions (the three-way interaction was not significant). In contrast, the SOS measure of self-acceptance (Table 5.9) is characterized by two main effects. Grade level was the strongest factor, with older students again attaining higher scores ($p = .03$). But change also systematically influenced outcomes, with positive change from pre-to-post measure being manifest across grade level and across participation year ($p = .08$). The last self-oriented construct examined, self-security (SOS), partially corroborated these results (Table 5.10). That is, grade level

Table 5.8

SELF-ESTEEM (SSCT)

	Participation Year I		Participation Year II	
Change	Grade Level		Grade Level	
	Lower	Higher	Lower	Higher
Pre	25.8	29.3	34.0	28.5
Post	25.8	36.5	29.2	31.5

Source	F	p
Participation Year	.67	n.s.
Change	.52	n.s.
Grade Level	2.40	13
Year X Change	1.4	n.s.
Year X Grade	6.15	.02
Change X Grade	3.98	.06

emerged here too as a strongly influential factor ($p = .008$), with older students scoring higher, as before; in this instance, however, grade level was the only significant source of variation.

In summary, longitudinal analyses provide a view of self-oriented constructs not essentially different from the one generated in within-year studies: there is no strong systematic evidence of change, and the interpretation of effects is problematic. The one clear result is that older students scored higher on self-oriented measures. It is possible that this effect in part represents method variance, as we have suggested earlier in this section, since the SOS is a verbal instrument and its relationship to reading ability might place younger students at a disadvantage. However, that the result is supported by analysis of the nonverbal SSCT measure suggests that the effect for

Table 5.9

SELF-ACCEPTANCE (SOS)

	Participation Year I		Participation Year II	
	Grade Level		Grade Level	
Change	Lower	Higher	Lower	Higher
Pre	52.5	56.3	52.0	57.0
Post	53.2	58.8	55.8	59.9

Source	*F*	*p*
Participation Year	.23	n.s.
Change	3.51	.08
Grade Level	5.56	.03
Year X Change	.44	n.s.
Year X Grade	.002	n.s.
Change X Grade	.03	n.s.

grade level represents real differences in self-attitudes between older and younger students. On the one hand, this outcome is curious, since studies of other disadvantaged populations suggest that older students, more aware of social attitudes and social comparisons, can be expected to show declining self-attitudes. In addition, to the extent that self-oriented dimensions are affected by school performance, it would be expected that older students, more distant from grade-level norms, would evidence more negative attitudes. On the other hand, longitudinal analyses of achievement and related skills indicated that older students made steadier, stronger gains, an experience which could be accompanied by increasingly positive self-attitudes. Finally, there is some evidence, less strong, for within-year gains in self-evaluation, at least for older students and at least during the first intervention year.

Table 5.10

SELF-SECURITY (SOS)

	Participation Year I		Participation Year II	
	Grade Level		Grade Level	
Change	Lower	Higher	Lower	Higher
Pre	50.8	55.5	42.0	62.1
Post	48.5	58.3	47.5	60.1

Source	F	p
Participation Year	.008	n.s.
Change	.36	n.s.
Grade Level	8.90	.008
Year X Change	.20	n.s.
Year X Grade	1.33	n.s.
Change X Grade	.12	n.s.

If anything, conclusions from longitudinal analyses of self-oriented attitudes were strengthened by attrition analyses. Those examinations produced no significant sources of variation in self-security (SOS) scales. However, both self-esteem (SSCT; $F = 6.40$, $p = .02$) and self-acceptance (SOS; $F = 3.08$, $p = .09$) showed significant positive change across groups; such an effect had been evident in self-acceptance scores but not in self-esteem scores for the participant group alone. Neither measure was substantially influenced by group or by the interaction of group with rate of change.

Social Dimensions

Five measures of social constructs were examined longitudinally. Social maturity scores (SOS) are treated first, separately, since the

remaining four dimensions are all specifically focused at the school setting. As Table 5.11 indicates, grade level had a very substantial effect on social maturity, with older students scoring higher (p = .001). In addition, a main effect appears for change, pre-to-post gains being evident across participation years (p = .04). These results are to be expected; that is, to the extent that the scale actually measures social maturity, there should be gains for all students each year and means should be higher for older than for younger students at each assessment. While these results lend some confidence in the validity of SOS scales, they cannot be interpreted as reflections of the ICTS intervention, but rather as representative of ordinary maturation effects.

Table 5.11

SOCIAL MATURITY (SOS)

	Participation Year I		Participation Year II	
Change	Grade Level		Grade Level	
	Lower	Higher	Lower	Higher
Pre	40.2	51.7	29.0	54.5
Post	38.5	55.8	34.8	57.5

Source	F	p
Participation Year	.64	n.s.
Change	5.07	.04
Grade Level	35.23	.001
Year X Change	1.56	n.s.
Year X Grade	2.24	.15
Change X Grade	.38	n.s.

Analyses of attitudes toward the school setting are summarized in Tables 5.12 through 5.15. Outcomes on the overall school affiliation scale (SOS) are given in Table 5.12, where both change ($p = .02$) and the interaction of grade level with change ($p = .07$) are significant: affiliation scores appeared to decline within the school year, especially for younger students. These results were not wholly anticipated on the basis of within-year studies, where the SOS school affiliation measure had yielded significant negative change only in year three. School-related attitudes assessed by the SSCT tap aspects of intimacy and extensiveness of social contact in that setting. Tables 5.13 and 5.14 present information about social distance from teachers and peers, respectively, while Table 5.15 presents information about the scope of peer attachment. (It should be recalled that for social distance measures, smaller scores represent increasing closeness.) It is apparent in Table 5.13 that perceived closeness to the teacher was not at all influenced by any of the independent factors examined. Perceived closeness to other students (Table 5.14), in contrast, shows an effect for the rate-by-grade interaction term: among older students, perceived closeness to peers increased during the school year ($p < .05$). Finally, measures of the scope of contact with other students (Table 5.15) exhibit a main effect for grade level, with older students claiming more extensive peer networks ($p < .04$). These latter outcomes tend to corroborate results of previous within-year analyses.

The study of school-related social attitudes, like the study of self-oriented attitudes, finds the two measurement procedures yielding only partially overlapping results. Again, the SOS and the SSCT concur in establishing that grade level is a critical factor in explaining school attitudes. Younger students had lower scores on the overall school affiliation scale, and SOS results emphasized negative changes in their perceptions over time. In contrast, the SSCT results underscore more positive aspects of older students school experiences; their peer network grew and they felt closer to other students as the school year progressed. On the basis of social development literature (e.g., Henderson and Bergan, 1976), it was not surprising to learn that older students had stronger peer relationships than younger students,

Table 5.12

SCHOOL AFFILIATION (SOS)

	Participation Year I		Participation Year II	
Change	Grade Level		Grade Level	
	Lower	Higher	Lower	Higher
Pre	50.3	52.3	46.2	47.0
Post	41.7	52.2	38.5	45.0

Source	F	p
Participation Year	1.46	n.s.
Change	6.22	.02
Grade Level	1.46	n.s.
Year X Change	.02	n.s.
Year X Grade	.10	n.s.
Change X Grade	3.65	.07

Table 5.13

SOCIAL DISTANCE FROM TEACHERS (SSCT)

	Participation Year I		Participation Year II	
Change	Grade Level		Grade Level	
	Lower	Higher	Lower	Higher
Pre	6.3	5.0	4.5	6.8
Post	5.7	6.0	5.3	4.3

Source	F	p
Participation Year	.23	n.s.
Change	.16	n.s.
Grade Level	.00	n.s.
Year X Change	.12	n.s.
Year X Grade	.23	n.s.
Change X Grade	.19	n.s.

Table 5.14

SOCIAL DISTANCE FROM STUDENTS (SSCT)

Participation Year

Change	I: Grade Level Lower	I: Grade Level Higher	II: Grade Level Lower	II: Grade Level Higher
Pre	4.7	6.8	3.0	5.5
Post	6.0	3.7	3.0	4.4

Source	F	p
Participation Year	1.70	n.s.
Change	1.24	n.s.
Grade Level	.84	n.s.
Year X Change	.07	n.s.
Year X Grade	.99	n.s.
Change X Grade	4.49	.05

Table 5.15

SCOPE OF PEER ATTACHMENT (SSCT)

Participation Year

Change	I: Grade Level Lower	I: Grade Level Higher	II: Grade Level Lower	II: Grade Level Higher
Pre	13.0	18.3	14.2	18.4
Post	12.5	22.2	12.5	17.5

Source	F	p
Participation Year	.10	n.s.
Change	.03	n.s.
Grade Level	4.94	.04
Year X Change	1.93	n.s.
Year X Grade	.29	n.s.
Change X Grade	1.47	n.s.

although most previous work in this area did not involve handicapped students. Informal classroom observation suggests that the ICTS may have helped facilitate such peer interactions among partially sighted students, an effect which held up in the long run only for the older subjects. However, the data obtained from younger subjects regarding both self- and socially oriented attitudes suggest that the socio-emotional climate for severely handicapped students in the lower grades deserves special attention.

Attrition analyses lend support to some of the conclusions drawn from longitudinal studies of socially oriented attitude measures and weaken others. The first variable examined, social maturity (SOS), showed no effect for group or for the interaction of group with rate of change. Interestingly, however, when scores of the attrition group were combined with scores from the participation group, the rate of change was no longer significant. Apparently those who dis-enrolled were not advancing along the social maturity scale as rapidly as their counterparts who remained in the project, although the difference only weakened the influence of rate of change instead of establishing a significant interaction term. The participation sample, then, included subjects whose assessed social maturity may have increased more rapidly than the overall rate among the subjects as a whole.

Similarly, when the school affiliation (SOS) variable was examined in this way, it too failed to yield a significant effect for rate of change, even though such change had been established in the longitudinal analysis. In this instance, the examination also generated an approximately significant group-by-rate interaction term ($F = 2.58$, $p = .13$), indicating that the attrition group became less disaffected with school during the year than did the participation group. Longitudinal analyses, then, may overestimate declines in school affiliation.

With respect to the two social distance measures (SSCT), inclusion of the attrition group in a Participation Year I analysis produced no change in outcomes; means remained stable and no effects appeared for group or group-by-rate interaction. Comparable findings came from the analysis of the peer attachment measure (SSCT), except

that the effect for rate of change was much stronger when the attrition group was included in the first year sample. Longitudinal analyses, then, may overestimate social maturity and underestimate affiliative feelings about the school setting among ICTS students.

AFFECT ENCODING AND DECODING

Pre-test, post-test, and change scores on the IPPT facial affect recognition test (which was given only in year three) appear in Table 5.16. The scores show no significant tendency to improve, and the means remain rather low. We suspect that, in part, these results reflect the inadequacy of the test itself, for several reasons. First, previously collected data (see CIRCUS 12) suggest recognition skills have improved. Second, affect reproduction scores to be discussed below do show advances--and reproduction is generally assumed to be more difficult than, if not dependent on, recognition. Finally, the photographs employed as stimuli in the IPPT are not ideally suited for testing partially sighted students because the contrast cannot be made sufficiently sharp. Thus it is possible that outcomes represent visual problems rather than affect recognition problems; an instrument relying on more sharply defined or cartoonlike features would have to be devised to circumvent this confound. While instrument development was beyond the scope of this research project, we nevertheless think it would be fruitful to further explore affect recognition in partially sighted students.

In addition to affect decoding, we also investigated affect encoding among our subject population. We were interested in learning whether partially sighted students could produce conventional facial signs of surprise, fear, disgust, anger, happiness, and sadness. For this purpose we employed an affect expression task based on the work of Ekman and Friesen (1975). Briefly, each subject was photographed while "making a face" expressive of the target affect; facial affect was then scored according to criteria developed by Ekman and Friesen. Facial affect data appear in Table 5.17, which presents data for each ICTS subject in the Killian site (201 to 217) only. Following each partially sighted participant's identifier are scores obtained from

Table 5.16

INTERPERSON PERCEPTION TEST, 1977-1978

Subject	Pre-test Score	Post-test Score	Pre-Post Change
Site I			
103	5	3	-2
104	10	10	0
107	7	3	-4
Site II			
201	17	9	-8
204	3	6	+3
207	5	7	+2
208	9	9	0
210	8	8	0
212	7	10	+3
213	10	10	0
215	14	11	-3
216	8	9	+1
217	16	10	-4
Means	9.2	8.1	-0.9
Range		(0-20)	

Table 5.17

FACIAL AFFECT PRODUCTION, 1977-1978

Subject (Site II)	Matched Control Score[a]	Pre-test	Post-test	Pre-test Distance from Control	Post-test Distance from Control	Pre-Post Change
201	5.7	2.6	10.6	-3.1	+4.9	+8.0
204	5.4	1.4	7.8	-4.0	+2.4	+6.4
207	9.7	4.3	6.4	-5.4	+3.3	+2.1
208	8.9	3.0	10.5	-5.9	+1.6	+7.5
210	5.6	2.8	8.4	-2.8	+2.8	+5.6
212	9.1	2.5	10.0	-6.6	+0.9	+7.5
213	5.1	1.5	11.0	-3.6	+5.9	+9.5
214	6.3	2.9	8.4	-3.4	+2.1	+5.5
215	7.4	3.3	8.8	-4.1	+1.4	+5.5
216	8.1	3.1	9.3	-5.0	+1.2	+6.2
217	9.2	2.7	11.5	-6.5	+2.3	+8.8
Means	7.3	2.7	9.3	-4.6	+2.6	+6.6

Range = 0-12

[a]Control subjects were administered the test only once.

a control subject matched for grade level, sex, and measured intelligence. Each photograph was scored (range = 0 to 2) independently by three judges. Scores in Table 5.17 represent the means of the scores. The pre-test difference between partially sighted students and their matched controls is striking: control participants systematically scored higher than the partially sighted students with whom they were matched (Wilcoxen $T = 0$, $p < .01$), indicating a potential role for ICTS intervention in affect communication.

Teachers in the Killian site during the 1977-1978 school year gave special attention to facial affect encoding. As Table 5.17 reveals, the difference between pre- and post-test scores for partially sighted students was as great ($T = 0$, $p < .01$) as the original difference between partially sighted students and their matched controls. ICTS students gained in affect production for each of the six expression types, these gains characterizing every student. Consequently, at post-test the scores of the partially sighted students did not significantly differ from the pre-test scores of their fully sighted peers. Figures 5.1 through 5.5 show dramatic pre-post differences in facial affect for five Site II subjects. We believe these results are encouraging, and suggest that affect communication could be included in curricula for partially sighted students to assist them in developing interpersonal competence.

CONCLUSIONS

The psychosocial assessment of participating ICTS students included factors affecting test performance, self- and social attitudes, and affect encoding and decoding. Although students' achievement test performance improved remarkably over the three years of the study, their attitudes toward tests remained distressingly consistent and negative. Because of the lack of change in these attitudes during years one and two and the lack of correlation between attitudes and test performance, we discontinued this assessment after two years. The failure experiences accumulated by visually impaired students appear to have generated negative attitudes toward test-taking that seem difficult to overcome.

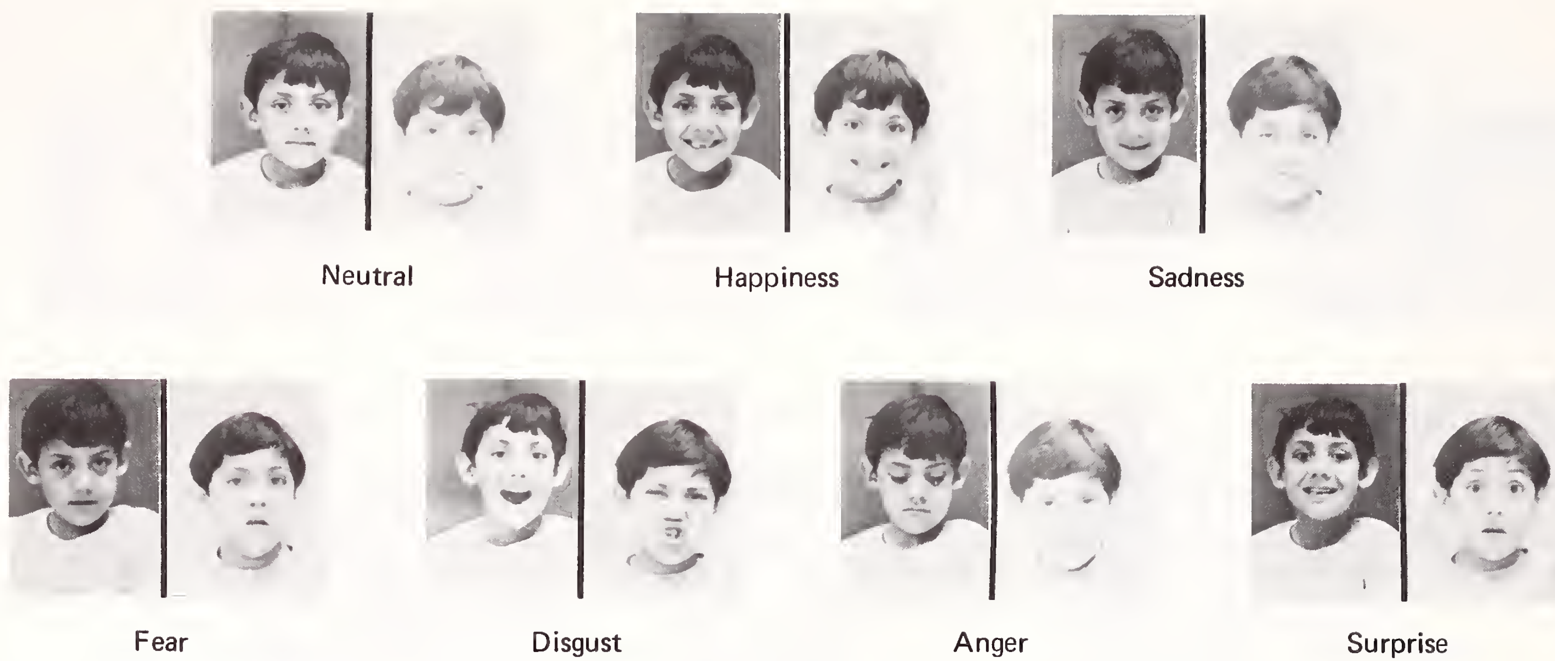

Fig. 5.1—Pre/post facial affect data for subject aged 6: pre-photo left, post-photo right

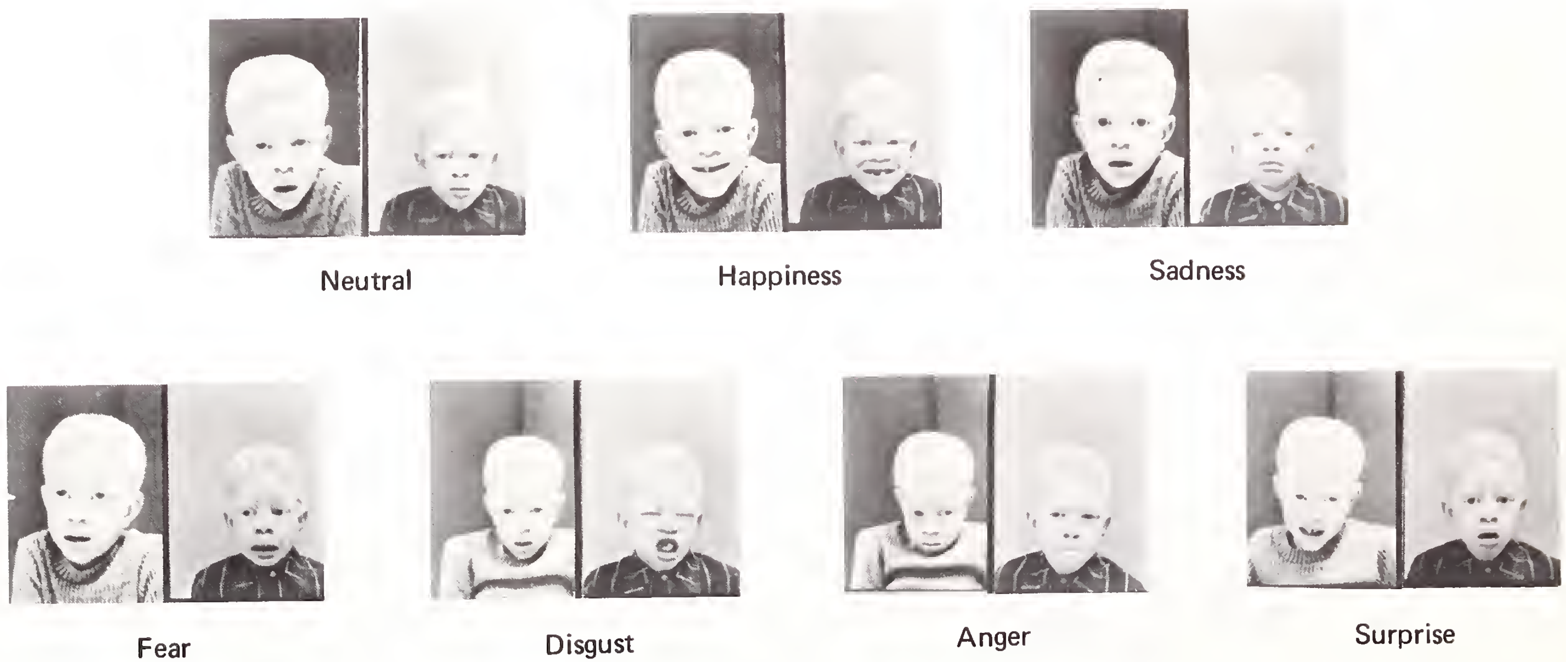

Fig. 5.2—Pre/post facial affect data for subject aged 7: pre-photo left, post-photo right

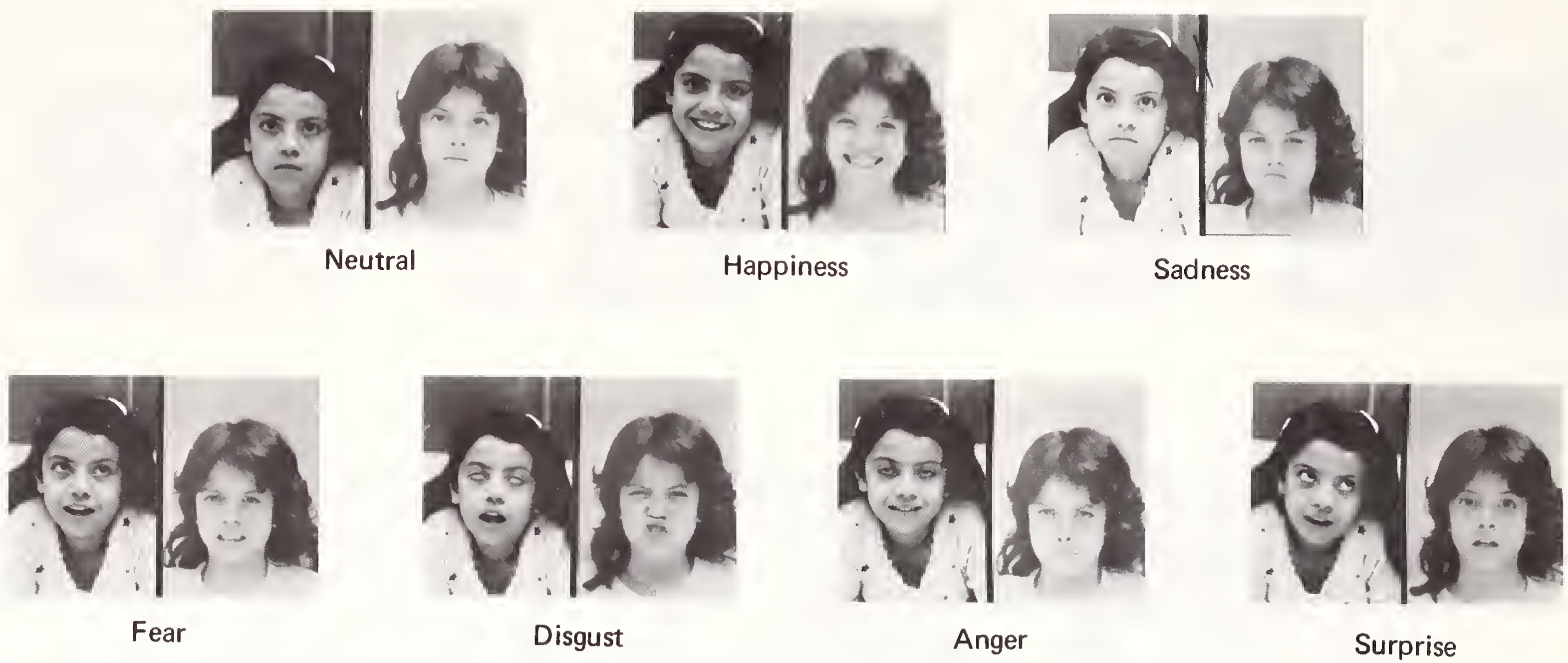

Fig. 5.3—Pre/post facial affect data for subject aged 9: pre-photo left, post-photo right

Fig. 5.4—Pre/post facial affect data for subject aged 10: pre-photo left, post-photo right

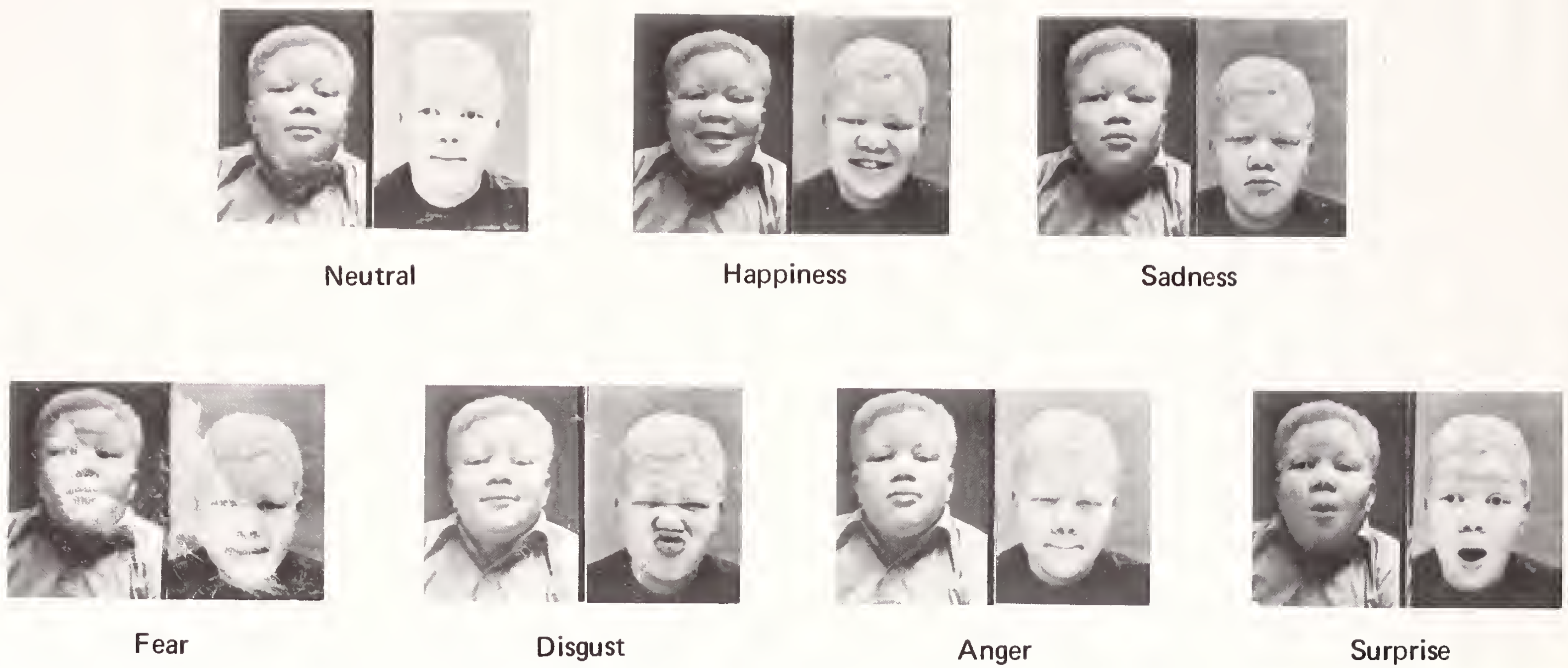

Fig. 5.5—Pre/post facial affect data for subject aged 12: pre-photo left, post-photo right

The first year's data indicated no overall improvement on any measures of self- and social attitudes, but data from the second year showed considerable positive change on such important dimensions as self-esteem and peer affiliation. In the third year, self-esteem showed no change, but social distance measures for the first time evidenced a systematic decrease, particularly in the area of social distance from other students. This result was paralleled by a systematic increase in the scope of peer attachment. However, participating students' interest in peers did not seem to be accompanied by a feeling of actually being included in broader social groups; by the end of the three years, ICTS students still seemed to perceive themselves more as individuals than as similar to other students.

Longitudinal analyses of self-oriented attitudes generally confirmed the within-year results. The strongest result was that older students scored higher on self-oriented measures. In addition, social maturity scores were higher for older students, an outcome not reflective of ICTS intervention.

In the area of school-related social attitudes, grade level was once again found to be an important factor. Younger students had lower scores on the overall school affiliation scale, and their perceptions changed in a negative direction; in contrast, older students had stronger peer relationships and felt closer to other students over time. These findings together with younger students' self- and social attitudes suggest that special attention should be given to the socioemotional climate for lower-grade visually impaired elementary school students.

Attrition analyses strengthened our conclusions about self-attitudes and qualified conclusions drawn in the area of social attitudes. The participation group seems to have included subjects whose social maturity advanced more rapidly than that of the attrition group, and whose school affiliation declined in comparison with that of the attrition group. Thus, longitudinal analyses may have overestimated the social maturity and underestimated the school affiliation of ICTS students.

Affect decoding scores were generally low and showed almost no improvement; however, these results may well be attributable to in-

adequate test methods. In the area of affect encoding, on the other hand, we found that Killian students, whose teachers paid particular attention to facial affect in 1977-78, improved markedly. At post-test these students' scores did not differ significantly from the pre-test scores of the fully sighted control group. These results indicate that with special visual aides and emphasis in their curricula, partially sighted students can make strong gains in affect encoding, an important aspect of social competence.

VI. CLASSROOM BEHAVIOR

The last kind of student information tapped by project evaluation concerned classroom task behavior. Unlike the previous kinds of information gathered from test scores, this information resulted from systematic observations of ICTS classroom processes. Our pilot experience at the Madison site strongly suggested that the ICTS was providing partially sighted students with their first opportunity to receive and share their work visually in a way comparable to their fully sighted peers. Classroom observations were introduced to provide descriptive data related to the nature and impact of ICTS intervention within the classroom environment in general, and its effects on task behavior in particular. We hypothesized that ICTS intervention would increase task participation in terms of both individual autonomous behavior and group interactive behavior.

To perform these structured observations, we decided initially to use the Planned Activity Check (PLA-Check, Risley and Cataldo, 1973) to document students' involvement in academic tasks. PLA-Check was designed to allow an observer to make systematic low inference and robust checks on task-participation behavior. Knowing beforehand what activities are planned to occur on a given day in a classroom, the observer scans the classroom at fixed time intervals (up to every five minutes) and records: how many students are present for the activity ("attending"); how many of those present are on-task ("participating") rather than off-task; and the percentage of the total number present that the latter group comprises.

A set of such structured time-sampling observations, collected semimonthly from the experimental classrooms, was intended to yield a description of classroom processes that would allow us to evaluate the effect of the ICTS on-task performance. In particular, since we began classroom observation prior to the implementation of the Site II ICTS, we hypothesized that introducing the intervention would lead relatively abruptly to greater percentages of on-task behavior in that classroom as both students and teachers could work more effectively.

That is, the system would allow teachers to begin conducting group activities or assigning students independent machine-mediated tasks; consequently, much less time would be spent in waiting or in boring activity.

However, after almost two months of classroom observation, PLA-Check proved to be inadequate both in the level of task-behavior discrimination it affords and in its ability to document the effect of the ICTS on task involvement. First, a simple on-versus-off discrimination did not permit us to determine whether a student was using a machine or not and, if so, the extent to which the machine was mediating his or her task behavior. Second, in the original PLA-Check instrument, the "nonparticipating" category blurred distinctions between waiting behavior and behavior explicitly inappropriate to the designated activity; it also blurred the distinction between transitional behavior and off-task behavior. Third, in both classrooms, the student-teacher ratio was exceptionally low--much lower than the normal ratio represented in the classrooms in which PLA-Check is typically used. There the ratio was usually about 30:1; in both the Madison and Killian classrooms the ratio was never higher than 5:1, and very often it was 2:1. Given these ratios, there was virtually no opportunity for a student *not* to participate in some sort of assigned task, with or without the use of the ICTS. Moreover, given these low ratios, it became important to distinguish *teacher*-mediated task participation (on a 1:1 basis) from on-task behavior where a teacher was not required to mediate the activity. Thus, while the percent of participation would not change significantly after introduction of the ICTS, the nature of task performance might well shift; to document such changes we needed an instrument capable of assessing the extent of ICTS use for task performance with or without teacher guidance.

For these reasons, we developed a RANDSIGHT observation system (ROS, see Sample next page) modeled after PLA-Check. The new instrument makes behavior discriminations which were blurred in the original instrument and which were nevertheless important for any assessment of ICTS use.

Sample

RAND ICTS CLASSROOM OBSERVATION I

SITE: ______________________

DATE: ______________________

PAGE: ______

OBSV:

	MODE			ICTS					TRANS		MODE			NON-ICTS				TOTAL		COMMENTS
TIME	IND	INT - T	INT - P	onT/onS	W/ADULT	onT/offS	WAITING	off/TASK	ON	OFF	IND	GRP - T	GRP - P	on/TASK	w/ADULT	WAITING	off-TASK	#/Childs	#/Adults	

The ROS form distinguishes three kinds of behavior: (1) behavior with the ICTS, (2) behavior in making a transition from one activity to another, and (3) behavior not involving the system. The rationale for distinguishing transitional behavior was dual. First, with the original PLA-Check, transitional behavior was scored simply as non-participating behavior. Classroom teachers felt that this categorization was unfair, since the students are told to make transitions and those who proceed as directed are fully participating. Second, we were not interested in transitional behavior per se; rather, we make the distinction so as not to confuse this type of behavior with either ICTS or non-ICTS behavior.

ICTS and non-ICTS behavior categories (i.e., all behaviors other than transitional) are divided into mode and function. The *mode* designates how students are related to any given activity. These mode discriminations are important in assessing the impact of the ICTS. We needed to distinguish, for example, its use as an individualized optical aid from its interactive uses, which may be either teacher-mediated or peer-mediated. The *function* refers to the specific behavior of students within a given mode. Operational definitions follow for all items on the ROS instrument.

ROS OPERATIONAL DEFINITIONS

Time: Observations are done at fixed intervals, three minutes apart, for continuous 15-minute periods. At the start of each 3-minute interval, the classroom observer would walk by each student ICTS station (and/or each activity center) and note the specific functional behavior of each subject. Each data sheet represents one hour of observing time. The 15-minute segments may or may not be contiguous, depending on the activity involved. We are primarily concerned with academic task behavior and less concerned with behavior during free time or play time.

MODE (For ICTS Activities):

IND: Individual station monitor displays the image from the (same) station camera. In other words, the student* sees his/her own work, and is working

*This may include two (or more) students at the same station under adult direction.

independently of the other students even though other students may be working on the same assignment. In this mode, the student is using the system as an individualized optical aid only.

INT: Teacher-Mediated Interaction. This mode corresponds with the mode titled "Group-T" for non-ICTS activities. At least two station monitors are displaying the same image* regardless of its source, *and* the activity is directly mediated by a teacher/aide. This is exactly like a regular classroom situation; a one-many† relation obtains between the teacher and the class, allowing for interaction among the students as well.

INT-P: Peer-Mediated Interaction. This mode is distinguished from the Teacher-Mediated Interactive mode in that a teacher/aide is not mediating (in a directive sense) the activity, although the teacher/aide may be present as another participant. As above, at least two students must be involved with the same task; and either they are simply doing it together, or one of the students is tutoring the other.

<u>FUNCTION</u> (For ICTS activities):

<u>onT/onS</u>: (on-Task/on-System). "on-task" means that the student is actively participating in a teacher-designated task--in this case an ICTS task; "on-System" means that the student is (1) adjusting the camera or monitor, or (2) looking at the monitor's image while participating in the assigned task.

w/ADULT: This function differs from the previous function in two respects: (1) There is a 1:1 relationship between adult and student. Generally, the adult will be either a teacher or an aide, but given the constant flow of visitors in these classrooms, it could refer to a number of other adults. "Adult" refers to anyone beyond the elementary school level. (2) Student is on-task, but may or may not be on-system; since the student is working under the guidance of an adult, or is

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*In the case of split images, only the image from any one given station need be the same.

†Int-T, as well as Int-P, allows for a one-one relation between adult/peer and student, if, and only if, two station monitors are sharing the same material.

under adult observation, the student's focus may be on the adult and not on the ICTS monitor.

onT/offS: To be on-system, the necessary *and* sufficient condition is that the student is looking at the station monitor. Previous classroom observations have shown that students do not always use the monitor even though they may be fully on-task. The extent to which a student does not use the station monitor depends on his/her visual acuity or other visual parameters and on familiarity with the system.

WAITING: This behavior occurs within a designated activity (as distinct from transitional behavior), where the subject is waiting for assistance from a teacher/aide/peer and he/she is not using the equipment. Waiting behavior is clearly appropriate within many designated activities, but it clearly differs from task performance.

off-Task: Subject's behavior falls outside the parameters designated above. In this case the subject is not using the equipment, nor waiting, nor in transition, and/or creates a disturbance sufficient to require the intervention of an adult.

TRANS:* (Transitional behavior). A teacher/aide has directed an individual or the class to end one activity and to begin or proceed to another. Here on-versus-off discrimination is sufficient.

<u>ON</u>: Student proceeds as directed. Behavior will of course vary depending on the activity involved. Generally, however, specific directions are given, e.g., "go to a center," "line up at the door," and the like.

<u>OFF</u>: Student does other than as directed, or creates a disturbance sufficient to require the intervention of a teacher/aide.

<u>MODE</u> (For non-ICTS activities):

Non-ICTS modes are defined in the same way as ICTS modes, with the obvious exception that they do not involve ICTS mediation. A non-ICTS activity, then, is *any* activity specified to occur in some location other than at a ICTS station.

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*MODE and FUNCTION are collapsed for transitional behavior only.

FUNCTION (For non-ICTS activities):

The four functions listed are defined as above except that on-system, off-system discriminations are not relevant here. Hence "onT/onS" has as its analogue "on-TASK" only, and "onT/offS" has no analogue.

#childs: (Number of children/students). In this column we record the total number of students in the classroom, including subjects *and* nonsubjects.

#/adults: In this column, we record the total number of adults present in the classroom, including teachers, observers, visitors, and the like.

COMMENTS: This section, including the space above each 15-minute time sample, will include any information that may prove helpful for interpreting the time samples. For example, the observer will denote the kind of activity involved, where it is taking place, a roll call of subjects including those who leave (or come in) during a time sample, and so on.

In addition to revising Risley and Cataldo's PLA-Check, we diverged considerably from their noninteraction observation procedures. Briefly, Risley and Cataldo recommend that the observer remain silent and inconspicuous, avoiding interaction with students, in order not to disrupt classroom activities. We found, however, that pretending not to be there was more disruptive than acknowledging our presence and interacting as naturally as possible with the students. The students, in any case, were aware of the observer's presence and attempted to make sense of his activities; one student, after asking for and receiving six explanations of the observer's activities, finally grinned and said, "Oh yeah, I know, you spy on us, you're a spy." We decided that this basic perception of the observer as a spy, a threat, could be counteracted only if the observer first publicly acknowledged and explained his presence, and then became assimilated in the classroom's "ecosystem." Thus we developed and followed a highly interactive observation model. (For a full description of this observation model, see T. H. Bikson, 1977.)

In addition to structured observations, we obtained information on teachers' perceptions of classroom behavior by examining the daily

logs that teachers were asked to keep throughout the three years of the project. Teacher logs are excerpted in Appendix A.

RELIABILITY

Project personnel were reasonably satisfied with the ROS in that it provided relevant discriminations of subject task involvement. At the very least, observation data collected with this instrument would provide a descriptive profile of the ways in which students interfaced with an ICTS. Since the ROS was developed by project staff and since there was only one classroom observer, any statements based on these data would require repeated reliability checks. (Inter-observer correlations in the low 90s preceded fielding of the ROS.)

During the second project year, we formally tested inter-observer reliability in the following way. We located a separate TV camera and microphone at the Killian site, connected them to the ICTS videotape recorder, and instructed one of the teacher aides in the use of the equipment. The videotaping proceeded as follows: at the start of a given 15-minute observation period, the camera was trained on the classroom clock (with a sweep second hand); at a prearranged time the aid began filming, panning from the clock to where the classroom observer was beginning systematic observations. She would then track the observer with the camera as he made his rounds. During the filming, the aide was instructed to attempt both long and close shots of each subject; the camera was in a fixed position, but so situated that all stations could be filmed.

After the taping was completed, an additional month was allowed to elapse before the tape was reviewed. The classroom observer and another member of the project staff trained in use of the ROS then viewed the tape, each independently recording observations on a data sheet. The observer's videotape judgments were then compared both with his original observations and with those of the videotape observer. In both cases the rate of agreement again exceeded 90 percent. These correlations suggest that, like PLA-Check, the ROS affords a low inference and robust procedure of documenting classroom behavior.

OBSERVED TASK INVOLVEMENT

Observation data were collected over nine-month periods during the first two project years (1975-76 and 1976-77) and for the second semester only during the third project year (1977-78). However, since the PLA-Check proved to be inadequate for our purposes (as described above), we will report ROS observation only. These observations began in November 1975 at both sites and continued through June 1976 for the first project year Observations during the second year spanned the nine-month period from September through May. The third project year was problematic because of the original project start date. Funding began in February 1975 for a three-year period ending February 1978. Since our evaluation called for a minimum of two complete academic years at both sites, we requested a no-cost extension of the project through June 1978, allowing two full years of ICTS intervention at the second generation site. However, in order to avoid a cost overrun, we reduced all project evaluation activities to a minimum during the first semester of 1977-78. We were thus able to obtain two full years of observation of ICTS-mediated activities at Madison (fall 1975 through spring 1977) and two full years at Killian (spring 1976 through spring 1978), although these periods are not coextensive.

Table 6.1 displays the total number of ROS observation hours at both sites, along with the average number of hours per day and per year, by group. For purposes of identification, Group 1 denotes the Madison site (Site I). Groups 2, 3, and 4 denote the Killian site in the following way: during the first project year, all subjects (spanning Pre-K through 6th grade) worked together on the ICTS (Group 2). At the close of the year, the teachers decided to split the group according to age. They found that the younger subjects were unable to spend as much time focused on a given ICTS activity as were the older subjects. The younger subjects performed better when ICTS activity was interrupted more frequently with other physically active tasks. Beginning in Year Two, ICTS time was scheduled separately for the younger subjects (Group 3) and the older subjects (Group 4) in Site II. However, at times the two groups used the ICTS together,

Table 6.1

DURATION OF ROS OBSERVATIONS
(In hours)

	Year 1		Year 2			Year 3	
	Group		Group			Group	
Day	1	2	1	3	4	3	4
1	2.0	.75	1.00	.25	.75	.50	1.00
2	1.0	1.00	1.00	.75	1.25	0	1.00
3	2.0	1.50	1.25	.25	.75	.75	.50
4	1.25	1.25	.75	1.00	1.00	.50	.75
5	1.50	1.00	1.00	.75	.75	.50	.50
6	1.75	1.00	1.00	.75	.75	.50	.75
7	1.75	1.00	.75	.50	.50	.75	.75
8	1.50	.75	1.00	.50	.50		
9	1.75	1.00	1.00	.75	1.00		
10	1.50	1.00	1.00	.50	.50		
11	1.50	1.00	1.00	.50	.75		
12	1.25	1.00	1.00	.75	.75		
13	1.25	1.00	1.25	.75	.75		
14		.25	1.00	.50	.50		
15			.50	.75	.75		
16				.50	.50		
TOTAL	20.00	13.50	14.50	9.75	11.75	3.50	5.25
$\overline{X}$	1.54	.96	.97	.61	.71	.50	.75

with the older subjects assisting the younger subjects. It should be noted that Group 1 was not observed during the last project year, two years of observation data having already been obtained.

ROS Observation Variables

Values for ROS observation variables represent percentage of students observably engaged in a specified behavior at a particular point in time. We determined mean frequencies for each group, by each observation date, for each project year. Although the ROS system could have been used to track individual subjects over time, the primary

interest of this part of the evaluation was the impact of the ICTS on classroom processes. Consequently, groups of subjects constitute the appropriate units of analysis. A descriptive account of the implementation of ICTS classrooms is provided by the bar graphs in Figs. 6.1-6.4; they depict the percentage of time throughout the intervention period that subjects spent assigned to ICTS mode and the percentage of time they were observably engaged in ICTS on-TASK behavior. Subsequent information about group activities is organized by year in the following manner: after a discussion of the daily ICTS mode and on-TASK behavior, ROS mode variables are examined as a group, followed by an examination of the ROS functional variables.

Means were computed in the following way. First, for each variable scores representing numbers of subjects were summed for each 15 minute interval and converted to percentages of total subjects; next percentages were summed for each day and divided by the number of 15 minute periods for that observation day to yield mean daily percentages.

Data analysis involved three types of parametric T-tests.* For all variables we compared the two sites within each year; then we looked at the behavior of each site between years; and finally, we combined the two sites in order to investigate the overall relationship between two ROS variables representing on-TASK/on-SYSTEM and on-TASK/off-SYSTEM behavior.

ICTS Mode and Task Involvement

Figures 6.1 to 6.4 depict overall interaction with the ICTS for each group by observation day and by project year. If the following restrictions are kept in mind, then these graphs can be viewed as loosely representative of ICTS mode and task involvement. As mentioned, days depicted are observation days only; moreover, the percentages graphed stand for those times, during any given observation day, in which the subjects were being observed; and, finally, a greater total amount of time was spent observing ICTS-mediated than non-ICTS-mediated activities.

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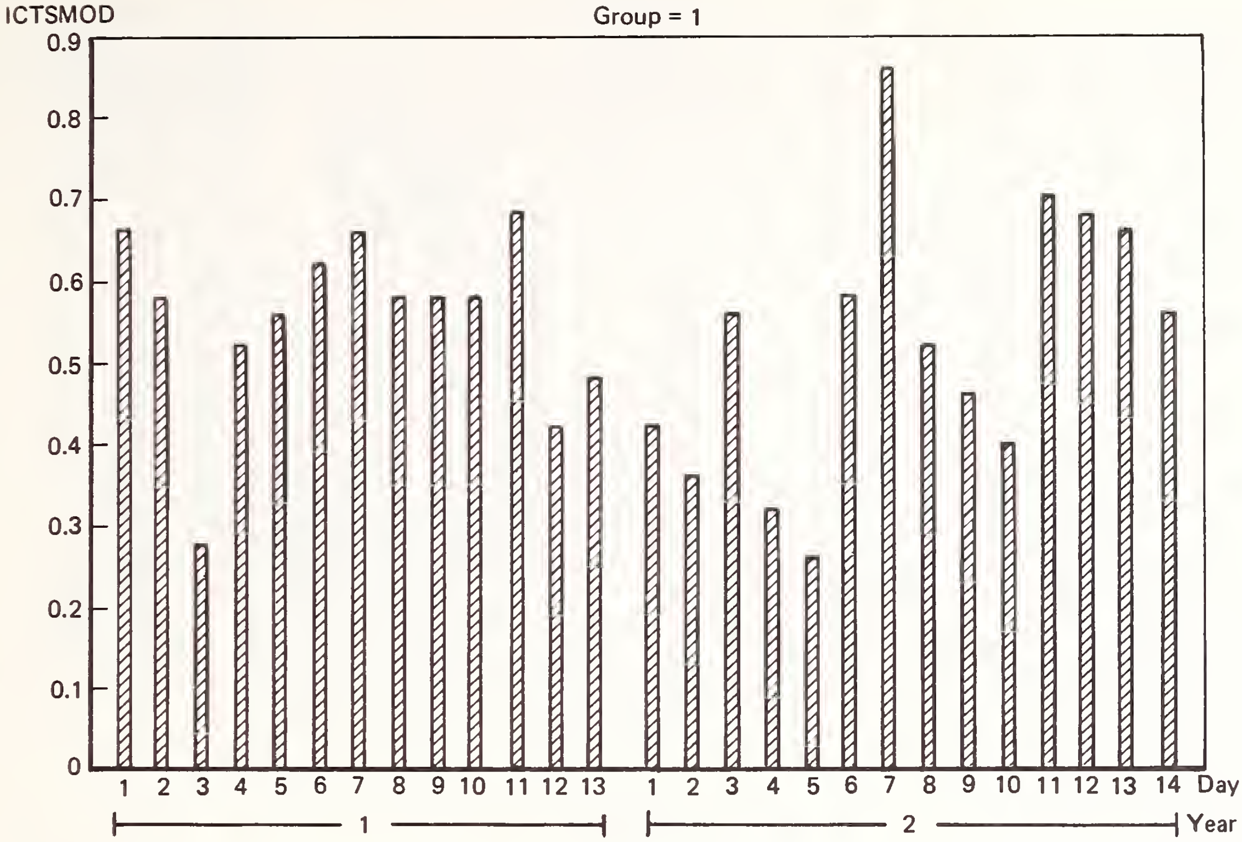
*The parametric T-test is a method for determining whether two sample means differ significantly (Fisher, 1960).

ICTS MODE



ICTS ON TASK

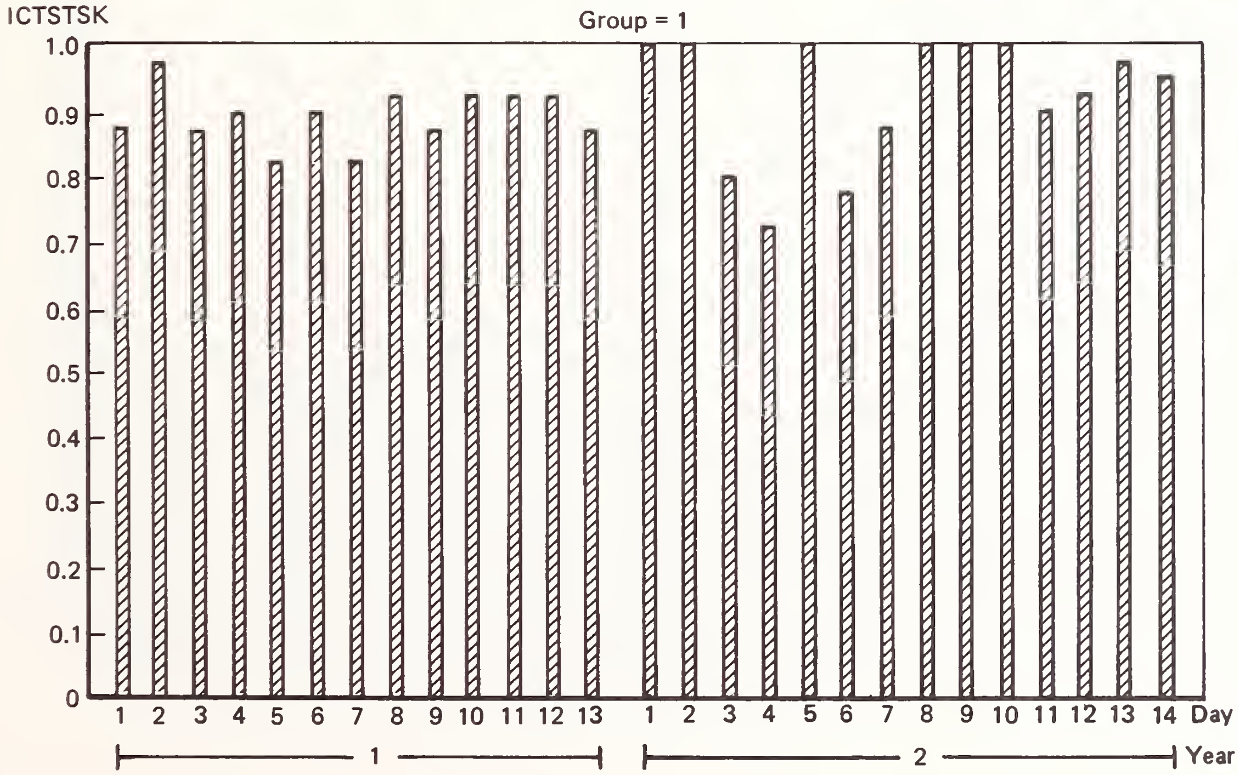
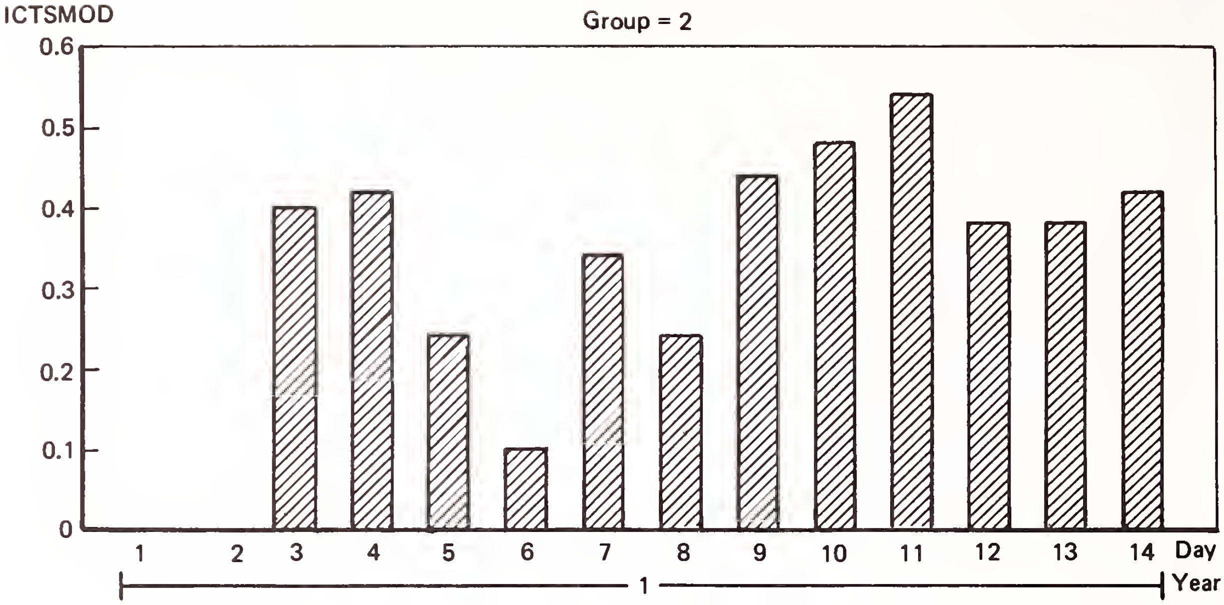


Fig. 6.1--ICTS Group 1

ICTS MODE



ICTS ON TASK

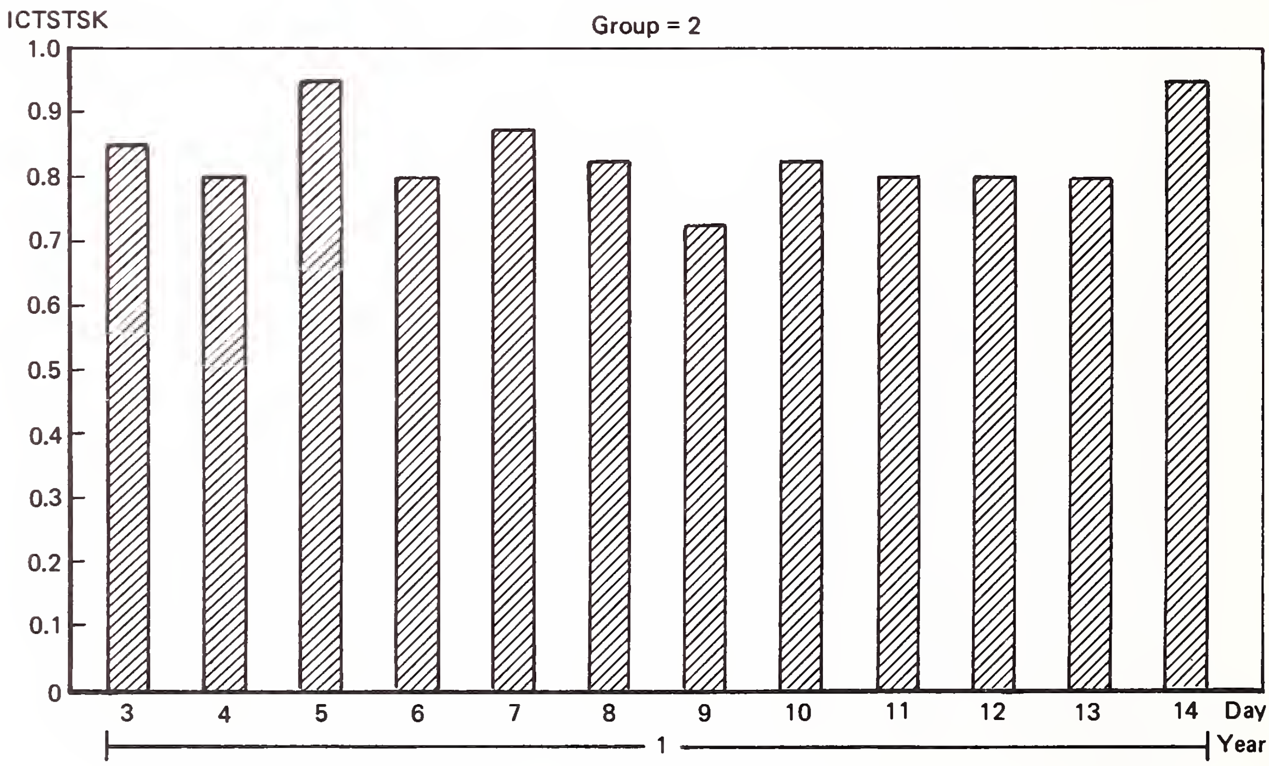
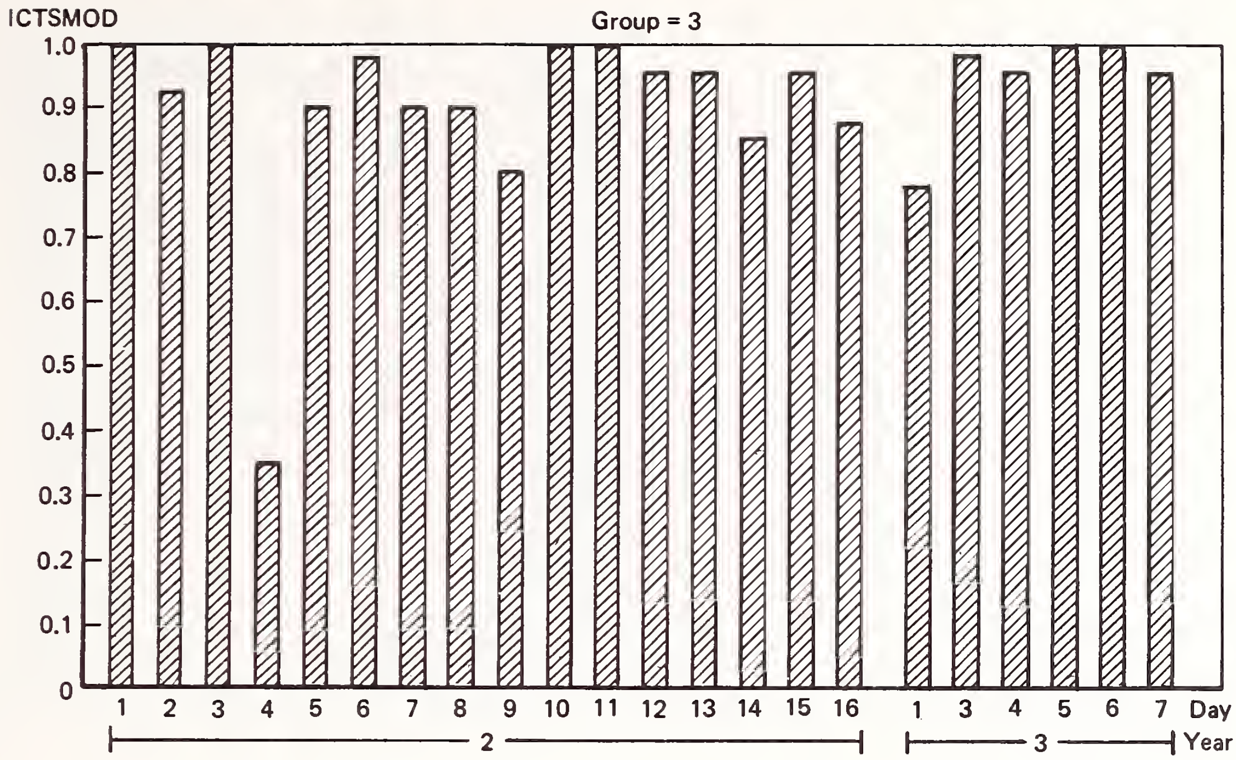


Fig. 6.2--ICTS Group 2

ICTS MODE



ICTS ON TASK

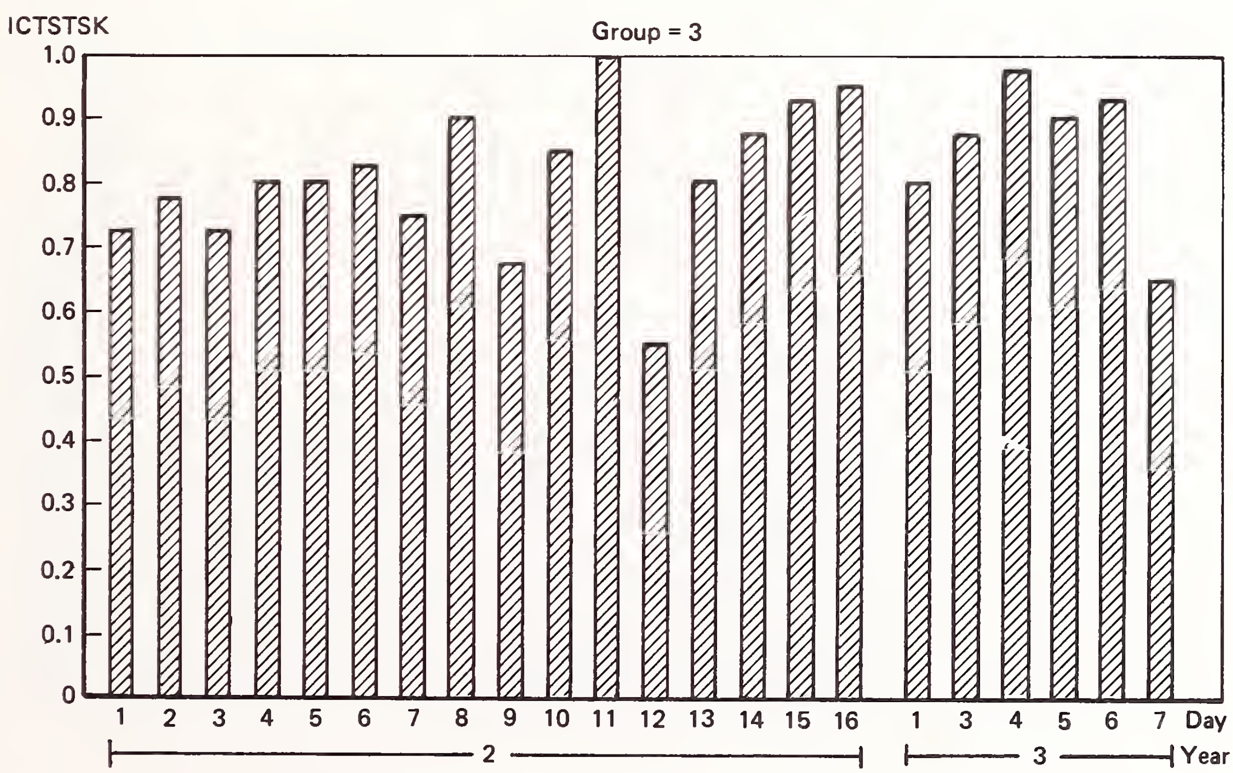
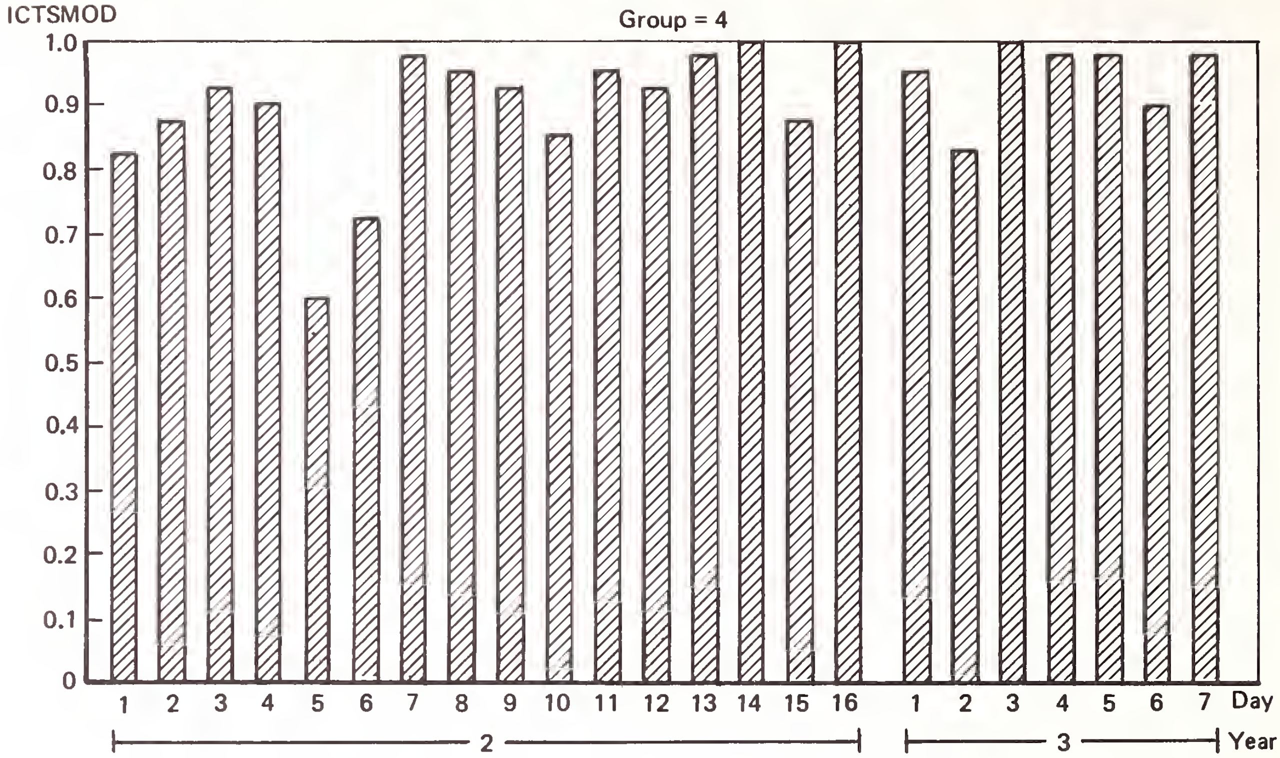


Fig. 6.3--ICTS Group 3

ICTS MODE



ICTS ON TASK

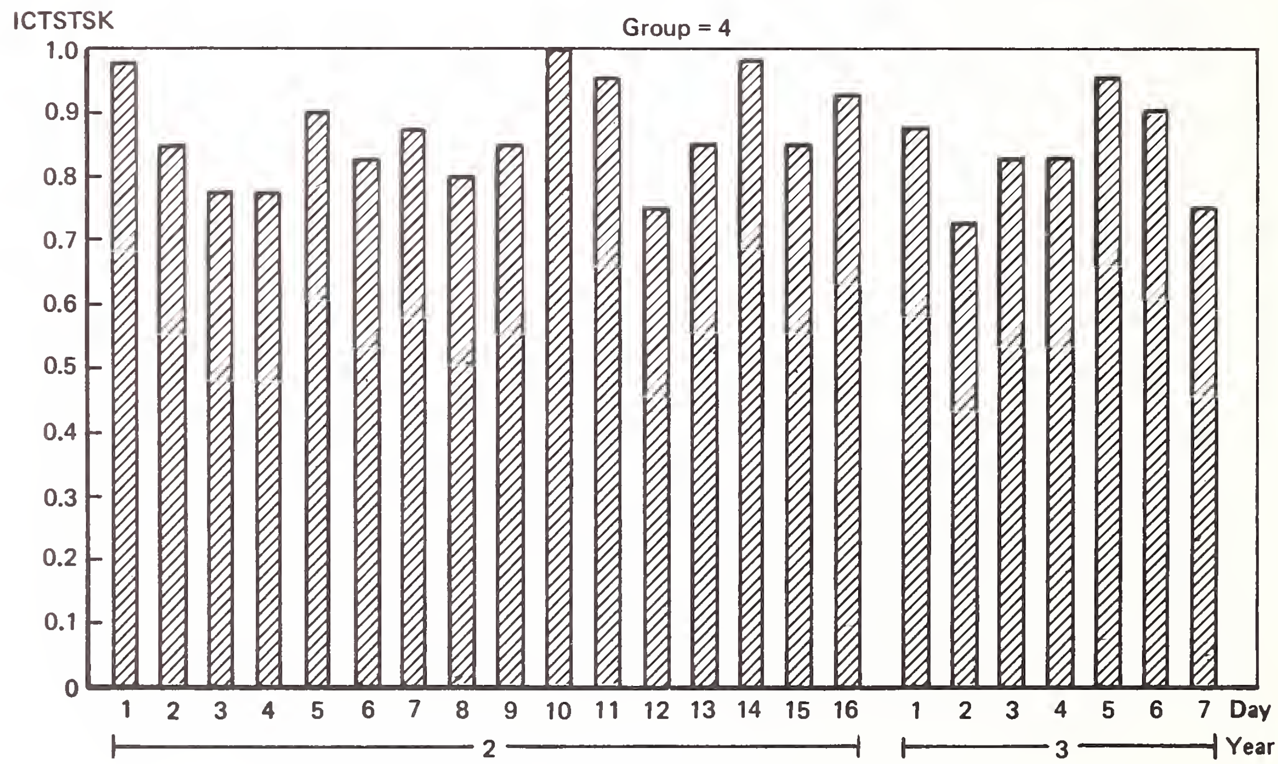


Fig. 6.4--ICTS Group 4

Each site was expected to devote a minimum of two hours per day to ICTS-mediated learning. With the exception of the Killian site during Year 1, daily mode percentages were high, exceeding 50 percent of observed behavior. Even the exception met the minimum time requirement. Overall, during Year 1, the Killian site spent approximately 33 percent of observed time in ICTS mode, despite the fact that the ICTS was not installed until November of that year and did not become fully operational until the following January. Given a six-hour class day at Killian, if actual observed time is representative of regular class days, then the 33 percent represents a little over two hours of ICTS-mediated learning per day. Daily schedules at both sites are considered in more detail below.

At the beginning of this section, we noted the following hypothesis: that ICTS intervention would increase task participation in both individual and group activities. A glance at the bar graphs depicting ICTS on-TASK behavior shows yearly mean percentages ranging from a low of 72 percent (Killian, Year 1) to a high of 89 percent (Madison, Year 1), well exceeding our expectations. Perhaps it is appropriate here to raise the issue of possible Hawthorne effects. It could be supposed that, given this massive intervention into the classroom environment, the students would perform better simply because of the increased attention paid to them. In fact, in addition to the large proportion of adults regularly in the classroom, there was (and continues to be) a steady stream of visitors at both sites, including project personnel, school psychologists, visiting VH teachers, student-teachers, and administrators, parents, politicians, and the press. It is possible that the rate of visitors increased during the project, as more people heard about the ICTS. Education for the handicapped has long generated this kind of attention, and partially sighted students are used to working in a fishbowl. Handicapped children learn at a very early age that they are different, and that they are treated differently from their non-handicapped peers. Most of their fishbowl existence in the classroom seems to be taken in stride; the students generally pay little or no attention to the hubbub that often surrounds them. It is consequently

doubtful that Hawthorne effects explain high ICTS task participation rates throughout the three-year project.

The following anecdote is illustrative. In Year 3 of the project, we produced a film about ICTS classrooms entitled *Visual Equality* (Huneck and Bikson, 1978). During the filming, the cameraman would often shoot closeups of a student at his or her ICTS station. This situation required the student to be surrounded by the cameraman, his assistant, and a person handling the directional microphone; on the immediate periphery were the rest of the film crew, assorted visitors, and, of course, the other students. This clearly was not a normal classroom environment even for an ICTS site, and the teachers neither expected nor demanded normal task involvement. Despite many strange bodies, cameras, lights, sound equipment, and shouted directions, those students not directly on camera generally continued to work as if nothing unusual was going on. This pattern of behavior was most startling for those of us who witnessed the proceedings. As far as student behavior was concerned, it appeared as if the fishbowl had just become a bit more hectic during the two days of filming.

Mode Behavior: Between Sites Within Years. Although observations were time-structured within 15-minute intervals, these intervals were not always contiguous but reflected the actual occurrence of primarily academic activities. Since our main interest was ICTS-mediated activity, we made the majority of our observations with subjects in this mode. Table 6.2 lists mean percentages of students engaged in different modes of activity on both an ICTS and non-ICTS basis by group for each project year. (It should be noted that Group 2 is divided into younger and older students, represented by Groups 3 and 4, respectively, for Years 2 and 3.)

Results of parametric T-tests used to evaluate between-site differences in percentages for each year are displayed in Table 6.3 for ROS mode variables; however, neither the peer-mediated interactive modes nor the transitional modes are included because of the relative infrequency of these kinds of observed behavior, as is evident in Table 6.2. Moreover, between-site comparisons are available for Years 1 and 2 only, since Group 1 (Madison) was not observed during Year 3.

Table 6.2

MODE BEHAVIOR

Variable Name	Abbre-viation	Year 1 Group 1	Year 1 Group 2	Year 2 Group 1	Year 2 Group 2	Year 2 Group 3	Year 2 Group 4	Year 3 Group 2	Year 3 Group 3	Year 3 Group 4
		ICTS								
Individual	IND	.43	.15	.30	.08	.04	.13	.43	.48	.38
Interactive--Teacher	INT-T	.13	.18	.20	.76	.80	.72	.46	.41	.50
Interactive--Peer	INT-P	.004	.00	.00	.02	.01	.04	.06	.05	.06
		Non-ICTS								
Transition--On	TRANS ON	.10	.12	.07	.06	.05	.07	.06	.05	.07
Transition--Off	TRANS OFF	.01	.02	.01	.002	.002	.003	.00	.00	.00
Individual	IND	.14	.22	.09	.02	.03	.02	---	---	---
Group--Teacher	GRP-T	.16	.27	.31	.04	.06	.02	---	---	---
Group--Peer	GRP-P	.02	.04	.03	.00	.00	.00	---	---	---

Table 6.3

ROS MODE VARIABLES: BETWEEN SITES, WITHIN YEAR

Mode	Variable Name	Direction of Differences Between Groups	Year	T	Significance
ICTS	IND	1 > 2	1	5.33	$p < .01$
ICTS	INT-T	1 < 2	1	0.89	n.s.
Non-ICTS	IND	1 < 2	1	2.11	$p \geq .04$
Non-ICTS	GRP-T	1 < 2	1	1.94	$p = .06$
ICTS	IND	1 > 2	2	3.70	$p < .01$
ICTS	IND-T	1 < 2	2	9.22	$p < .01$
Non-ICTS	IND	1 > 2	2	1.69	n.s.
Non-ICTS	GRP-T	1 > 2	2	4.78	$p < .01$

The significant between-group variation shown in Table 6.3 is, we believe, primarily a result of site-specific factors. First, in Year 1 the Madison site logged more ICTS mode behavior (56 percent) than the Killian site (33 percent); conversely, Killian logged more non-ICTS observed behavior (49 percent) than Madison (30 percent). In the main, this can be attributed to the fact that observations began in November 1975 at both sites; however, the ICTS at Madison was in its second full year of implementation, whereas the ICTS was installed at Killian only in November 1975 with full implementation not apparent until January 1976. Killian teachers and students, then, were in the process of getting used to the system; it was far from a regular part of their routine when observations started.

Year 2 shows the converse relation between sites, with Killian exhibiting more ICTS behavior (86 percent) than Madison (50 percent). In part this is again due to a between-site difference in access to the ICTS. At Madison, subjects were in the ICTS room for the morning only, then mainstreamed into normal classrooms in the afternoon for primarily nonacademic activities. Subjects at the Killian site were in a self-contained classroom for the entire day; also, in Year 2 the Killian group was divided into a younger and an older group (Groups 3 and 4). These circumstances allowed the teachers at Killian more latitude for setting up ICTS-mediated activities. The result is particularly reflected in comparing both sites during Year 2 over non-ICTS mode variables 11 and 12 (see Table 6.3). Whereas there was no significant difference between sites with respect to non-ICTS individual mode behavior, there was significantly more observed non-ICTS teacher-mediated interactive behavior at Madison primarily because at Madison Group 1 could be observed in both ICTS and non-ICTS modes. At Killian, however, for the vast majority of observed time, the group in the ICTS mode had to be observed while the other group was, at the same time, functioning in non-ICTS mode.

Second, the differences in mode behavior during Year 2 between the two sites also reflect a change in the composition of Group 2 at Killian.* Subjects in Group 1 (Madison) continued to span grade levels K-6, whereas the Killian site was divided into two groups spanning grades K-3 and 4-6, respectively, For example, ICTS individual mode behavior was significantly greater at the Madison site ($p < .01$), while ICTS teacher-mediated interactive mode behavior was significantly greater at the Killian site ($p < .01$). Nevertheless, Madison site data amply demonstrate the ability of students at different grade levels to interact with one another while using the same curricular materials. (See Table 6.2, Group 1, Year 2: ICTS Individual Mode, 30 percent; ICTS Teacher Interactive Mode, 20 percent.)

Mode Behavior: Within Sites Between Years. Mode behavior within groups between project years is displayed in Table 6.4. The Madison site shows significant decreases from Year 1 to Year 2 in both ICTS and non-ICTS individual mode behavior ($p \leq .02$ and $\leq .03$, respectively). Conversely, there was a small though non-significant increase in ICTS interactive mode, and a significant increase in non-ICTS interactive mode ($p < .01$). These increases were not due either to curriculum or to ICTS intervention changes; rather, the increases reflect the difference in Group 1 membership from Year 1 to Year 2. Compared with the Killian site, where there was greater time flexibility, the program at Madison was restricted to the morning hours only (2-3/4 hours). This required a relatively fixed schedule with respect to curriculum. However, group membership dictated how the curricula would be presented. Year 2 saw more interaction in the Madison classroom between the partially sighted ICTS subjects (n = 3) and the functionally blind students (n = 2); moreover, the adjoining resource room began to make more use of the ICTS room by viewing educational materials on the ICTS, as well as by participating in several nonacademic activities conducted in the ICTS room but not in the ICTS mode.

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*It should be remembered that in Year 2, Group 2 signifies the combination of Groups 3 and 4. Mean percentages for Groups 3 and 4 are shown in Table 6.2.

Table 6.4

ROS MODE VARIABLES: WITHIN SITES, BETWEEN YEARS

Mode	Variable Name	Group	Direction of Differences Between Years	T	Significance
ICTS	IND	1	1 > 2	2.44	$p \leq .02$
ICTS	INT-T	1	1 < 2	1.37	n.s.
Non-ICTS	IND	1	1 > 2	2.21	$p \leq .03$
Non-ICTS	GRP-T	1	1 < 2	2.70	$p < .01$
ICTS	IND	2	1 < 2	1.07	n.s.
ICTS	INT-T	2	1 < 2	10.03	$p < .01$
Non-ICTS	IND	2	1 > 2	6.14	$p < .01$
Non-ICTS	GRP-T	2	1 > 2	4.56	$p < .01$
ICTS	IND	2	2 < 3	3.00	$p \leq .01$
ICTS	INT-T	2	2 > 3	2.61	$p \leq .03$

As expected, the Killian site showed a tremendous increase (58 percent) in percentage of ICTS teacher-mediated interactive mode behavior from Year 1 to Year 2 ($p < .01$), along with a corresponding significant decrease in non-ICTS mode behaviors (IND, $p < .01$; GRP-T, $p < .01$). Although the ICTS individual mode did not change significantly, it did decrease slightly, reflecting the move toward more ICTS mode behavior generally in Year 2 at that site. Again, the significant differences between years for ICTS and non-ICTS mode behaviors seem to be due to the two factors discussed above. That is, by Year 2 the ICTS had functioned fully for at least six months in the Killian site, and it had been divided (3 and 4) into fairly homogeneous age groups, allowing for easier implementation of interactive activities.

Of particular interest in Table 6.4 is the shift of mode behavior at Killian between Years 2 and 3. Here a significant increase in ICTS individual mode behavior ($p \leq .01$) was observed, along with a corresponding significant decrease in ICTS teacher-mediated mode behavior ($p \leq .01$). Whereas Year 2 reflects a great deal of experimentation with ICTS interactive activities, Year 3 probably represents a more normal pattern of interactive and individual work

modes not unlike those observed at the Madison site. What appeared to determine this change at Killian was that work introduced by the teacher in an interactive mode was often completed later in the individual mode, with the students working at their own pace. In part this change reflects the teachers' desire for students to begin to take responsibility for their own work, and students' capabilities to work on their own at the ICTS. From time to time, students were instructed to proceed to their ICTS stations and complete work outstanding, with the teachers available for consultation on an as-needed basis. Finally, Table 6.4 shows that overall variation from Year 2 to Year 3 within Group 2 (the Killian combined group) reflects the percentage of increase observed for the younger and older groups separately.

The exploration of mode behavior at the two sites reflects both the implementation and continued use of an ICTS. In particular, an ICTS intervention into a VH classroom has generated a capability for two types of behavior generally absent from traditional VH classrooms: the ability of VH students to work autonomously, using their residual vision (ICTS individual mode); and the ability to work visually as a group (ICTS interactive teacher mode). We believe that the results of these kinds of behaviors are seen in terms of successful academic achievement (reading and mathematics) and related visual skills (visual motor integration and visual sequential memory). In both areas, the majority of subjects are approximating grade-normal performance, consequences that appear to be strongly linked with increased use of residual vision facilitated by an ICTS.

Functional Behavior

Functional behavior has been described as the specific behavior within a mode; e.g., if a subject is in the teacher-interactive ICTS mode, that subject could be on-TASK and on-SYSTEM (onT/onS), or in a one-one relation with an adult (w/ADULT), or on-TASK but off-SYSTEM

(OnT/offS),* or waiting for further instructions within a given activity (WAITING), or off-TASK (offT, i.e., not doing what was called for by the teacher), or in transition between different activities (TRANS). It should be noted that the concept of on-TASK is used in two senses. Generically, on-TASK refers to any behavior appropriate to a teacher-designated task in either mode. However, a subject may be on-TASK in several different ways: specifically, in the ICTS mode, on-TASK may denote onT/onS, onT/offS, w/ADULT, or WAITING; in the non-ICTS mode, on-TASK may denote TRANS ON, on-TASK, w/ADULT, or WAITING. Table 6.5 displays mean percentages of observed functional behavior for each group, by year. The recurrence of the transitional variables reflects their use to describe both mode and function variables; however, as with mode variables, observed transitions have not been included in the analyses.

The most notable finding in Table 6.5 is generated by the comparison of ICTS and non-ICTS off-TASK variables. On the average, only 16 percent of students were off-TASK over the three years of observation for all groups. Two factors are easily identifiable that may account for low percentage of off-TASK behavior. First, for several reasons, subjects enjoyed working with the ICTS. They quickly learned to adjust the camera and monitor to fit their own specific visual needs; they also learned to operate the remote control unit of the room camera as well as the teacher's control console. Being able to operate sophisticated electronic equipment was clearly enjoyable for them. Moreover, the ICTS provided them a first "clear" visual relationship with their peers, teachers, curricular materials, the chalkboard, and even themselves in action (as recorded on videotape in the classroom). In no way do the data reported here reflect the sheer joy of their discoveries.

Second, the child-adult ratio was exceptionally small, relative to normal public elementary school classrooms; thus, adult attention

*The concept of "off-SYSTEM" in this instance means that the subject is in ICTS mode (at an ICTS station) but is not using the monitor. The subject may be looking directly at a person speaking, or the subject may be looking directly at what he or she is reading or writing.

Table 6.5

FUNCTIONAL BEHAVIOR

Variable Name	Abbreviation	Year 1 Group 1	Year 1 Group 2	Year 2 Group 1	Year 2 Group 5	Year 2 Group 3	Year 2 Group 4	Year 3 Group 5	Year 3 Group 3	Year 3 Group 4
ICTS										
On-Task, on System	onT/onS	.21	.13	.20	.42	.32	.53	.24	.14	.35
With Adult	w/ADULT	.16	.08	.12	.14	.21	.07	.21	.35	.07
On-Task, off System	onT/offS	.09	.04	.10	.12	.10	.13	.30	.27	.32
Waiting	WAITING	.04	.03	.03	.06	.07	.04	.04	.04	.04
Off-Task	off-TASK	.06	.06	.05	.14	.17	.12	.15	.14	.16
Non-ICTS										
Transition on	TRANS ON	.10	.12	.07	.06	.05	.07	.06	.05	.07
Transition off	TRANS OFF	.01	.02	.01	.0002	.002	.003	.00	.00	.00
On-Task	on-TASK	.22	.34	.29	.05	.07	.03	---	---	---
With Adult	w/ADULT	.05	.09	.06	.007	.01	.004	---	---	---
Waiting	WAITING	.02	.03	.03	.00	.00	.00	---	---	---
Off-Task	off-TASK	.04	.07	.05	.002	.005	.00	---	---	---

was not a distraction, but helped keep students engaged in their work. However, to a certain extent, the ratio is misleading (see Table 6.6). As described above, the ratio includes all "adults" (not only teachers) and all children (not only subjects). In the state of California, the child-adult ratio for a VH classroom that houses multiply handicapped children must not exceed 8 to 1. However, there is no mandated ceiling for number of aides a VH teacher may have, including volunteers. At Killian, in particular, junior and senior high school students often assisted in the ICTS classroom, each one spending about a half hour. Even though the age differences between some of the student aides and the students in the classroom were small, the high school students nevertheless constituted in "adult" presence in their relationship to the partially sighted children. Moreover, at both sites, visitors, including parents, occasionally attended the classroom and were counted when their participation was relevant to the students.

Table 6.6

CHILD-ADULT RATIO

	Year 1		Year 2			Year 3	
	Group 1	Group 2	Group 1	Group 3	Group 4	Group 3	Group 4
Children:Adult	2.59	1.92	1.45	1.71	2.05	3.00	3.70

Adult presence is reflected in both ICTS and non-ICTS modes (Table 6.5), where "w/ADULT" is defined as a one-to-one relationship between student and adult. The overall average of observed student-with-adult behavior is 20 percent, which constitutes approximately one-fourth of all on-TASK behavior in both modes. The Killian site, for Years 2 and 3, shows a large percentage difference between Groups 3 and 4, reflecting the need for more adults to work with the younger subjects.

Functional Behavior: Between Sites Within Years. Comparison of between-site percentages for each year are displayed in Table 6.7. The direction of significant differences for each variable is indicated by the second column in that table; actual means were presented in Table 6.5. Variables "ICTS onT/onS" and "ICTS onT/offS" denote direct use of the ICTS by the subjects. With both variables, the Madison site during Year 1 shows significantly more observed use than the Killian site, as would be expected given differential experience with the system. Then, most likely (for reasons discussed in relation to mode behavior) the direction of difference shifts, so that Killian (Group 2) means are higher than Madison (Group 1) means for Year 2. This change in direction of differences likewise holds for on-TASK, on-SYSTEM behavior; there is also a similar but non-significant (2 percent) change in the same direction for on-TASK, off-SYSTEM behavior. A detailed analysis of onT/onS and onT/offS occurs below.

Table 6.7

ROS FUNCTIONAL VARIABLES: BETWEEN SITES, WITHIN EACH YEAR

Variable Name	Direction of Differences Between Groups	Year	T-Score	Significance
		ICTS		
on T/on S	1 > 2	1	2.48	$p = .02$
	1 < 2	2	4.70	$p < .01$
w/ADULT	1 > 2	1	3.01	$p < .01$
	1 < 2	2	0.41	n.s.
on T/off S	1 > 2	1	3.92	$p < .01$
	1 < 2	2	1.00	n.s.
WAITING	1 > 2	1	1.16	n.s.
	1 < 2	2	3.23	$p < .01$
off-TASK	1 < 2	1	0.52	n.s.
	1 > 2	2	4.24	$p < .01$
		Non-ICTS		
on-TASK	1 < 2	1	3.30	$p < .01$
	1 > 2	2	5.45	$p < .01$
w/ADULT	1 < 2	1	1.40	n.s.
	1 > 2	2	3.94	$p < .01$
WAITING	1 < 2	1	1.11	n.s.
	1 > 2	2	(a)	(a)
off-TASK	1 < 2	1	1.68	n.s.
	1 > 2	2	3.00	$p \leq .01$

[a]Observed waiting behavior.

The high percentage of ICTS individual mode behavior at Madison (relative to Killian) is reflected in with-ADULT behavior. From the observer's perspective, if the subject was in an individual mode, then any interaction with an adult was so recorded. However, if interactive mode behavior was being observed, subjects would not be recorded as "with an adult" unless an adult, other than the person directing the group, was assisting that particular student in a one-to-one relationship. Moreover, even when the group leader singled out the subject in a question, that behavior was recorded under onT/onS, onT/offS, or off-TASK variables if in ICTS mode, or on/TASK or off/TASK variables if in

non-ICTS mode. By Year 2, Killian ICTS mode behavior caught up with and exceeded that of Madison; there was, however, no related variation in with-ADULT ICTS mode behavior even though in non-ICTS mode, Group 1 logged significantly more with-ADULT time. Again, this variation in w/ADULT was probably due to the significant decrease in non-ICTS behavior observed during Year 2 at Killian.

The significant change in on-TASK behavior in the non-ICTS mode most likely reflects differences in mode behavior during Year 1. During Year 2, as reported above, Group 2 recorded more non-ICTS teacher-interactive behavior than Group 1. Group activities tended to produce more on-TASK behavior than did individual activities. In the main, this was due to the fact that adults (usually more than one) were directly involved with the former, but had only a passive presence for the latter. By Year 2, the situation again reversed even though, with respect to mean percentages, Group 1 remained the same from Year 1 to Year 2. The difference is due to the fact that Group 2 during Year 2 was rarely observed in the non-ICTS mode.

Finally, non-ICTS off-TASK behavior was extremely low in terms of mean percentages of observed time, nor did this off-TASK behavior vary significantly between sites for Year 1. Year 2 showed the same low percentage of non-ICTS off-TASK behavior at Madison (4 percent), which nevertheless was significantly greater than non-ICTS off-TASK behavior at Killian (.002 percent). As previously discussed, this was a function of the dramatic decrease in observed non-ICTS behavior at Killian. The other off-TASK variable (ICTS off-TASK) showed the reverse; here Killian logged significantly more off-TASK behavior than Madison.

The generally low incidence of off-TASK behavior across sites in both ICTS and non-ICTS modes was most surprising to project staff and teachers. There is the old adage (slightly altered) that kids will be kids and that no group of kids will do what they are told to do 80 percent or more of observed time. Without question, the low child-adult ratio was partly responsible, although if the students involved "liked" neither the activities nor the adults present, we would expect higher percentages of off-TASK behavior even with considerable adult presence.

However, the students at both sites appeared to be intrinsically interested in classroom activities, teachers, and teacher aides. (Subjects were of course not without complaints, particularly during pre- and post-test times.) Nevertheless, the question of observer effects here is appropriate: one could perhaps argue that the students "performed" for the observer when observed, and that the obtained low percentage of off-TASK time did not reflect the situation when students were not being observed. This problem was in part alleviated by the observation procedure described earlier in the section; central to the observation procedure was the assimilation of the observer within the classroom environment. As such, the observer became just another adult, in this case similar to teachers, aides, and other regular visitors. The classroom observer quite likely produced no more effects on behavior during the three years of data collection than any other regularly appearing adult, and was considerably less obtrusive than visiting strangers.

Functional Behavior: Within Sites Between Years. Functional behavior within sites between years is displayed in Table 6.8, with direction of differences found in the "year" column. Madison site data are presented first, followed by the Killian site data. Because Group 1 was not observed during Year 3, we can show comparisons for that group only between Years 1 and 2. For Killian each functional variable, with one exception, is listed twice: the first listing compares Years 1 and 2 for a given variable, followed by a second listing comparing Years 2 and 3 for the same variable. The one exception is the variable "w/ADULT," for which we found a significant difference between Years 1 and 3 when there were nonsignificant differences between Years 1 and 2 and Year 2 and 3. Finally, because non-ICTS activities were not observed at Killian during Year 3, we show comparisons for non-ICTS functional variables between Years 1 and 2 only.

Table 6.8

ROS FUNCTIONAL VARIABLES: WITHIN SITES 1 AND 2, BETWEEN YEARS

Variable Name	Direction of Differences Between Years	T	Significance
	Site 1 (Madison)		
ICTS			
on T/on S	1 < 2	0.05	n.s.
w/ADULT	1 > 2	1.64	n.s.
on T/off S	1 < 2	0.10	n.s.
WAITING	1 > 2	1.66	n.s.
off-TASK	1 > 2	1.19	n.s.
Non-ICTS			
on-TASK	1 < 2	1.47	n.s.
w/ADULT	1 < 2	0.85	n.s.
WAITING	1 < 2	1.32	n.s.
off-TASK	1 = 2	0.11	n.s.
	Site 2 (Killian)		
ICTS			
on T/on S	1 < 2	8.02	p < .01
on T/on S	2 > 3	3.14	p < .01
w/ADULT	1 < 2	1.62	n.s.
w/ADULT	2 < 3	1.23	n.s.
w/ADULT	1 < 3	2.66	p ≥ .01
on T/off S	1 < 2	5.54	p < .01
on T/off S	2 < 3	6.32	p < .01
WAITING	1 < 2	2.62	p ≤ .01
WAITING	2 > 3	1.08	n.s.
off-TASK	1 < 2	3.96	p < .01
off-TASK	2 = 3	0.16	n.s.
Non-ICTS			
on-TASK	1 > 2	8.58	p < .01
w/ADULT	1 > 2	2.76	p ≥ .01
WAITING	1 > 2		
off-TASK	1 > 2	2.45	p < .01

As reported in Table 6.8, the Madison site showed significant mode differences between Years 1 and 2 in that both ICTS and non-ICTS individual behavior varied inversely with ICTS and non-ICTS teacher-mediated behavior. Year 1 showed more individual behavior; Year 2 showed more interactive behavior. Despite these significant mode variations, what is notable about the Madison site is that there were *no* significant differences among any of the functional variables reported. In fact, the mean difference among the group means reported in Table 6.5 is only 2 percent. In short, the functional behavior of Group 1 was remarkably stable. Several factors can be singled out that help explain this stability. First, the subjects in Year 2 had all participated during the previous year, so for these subjects the teacher, classmates, and ICTS-mediated learning activities, as well as the school setting itself, were all familiar. Second, Group 1 met in the ICTS room for a maximum of 2-3/4 hours, in contrast with the Killian site, where students spent a minimum of 3-1/2 hours (preK and K) to a maximum of 6 hours (grades 4-6); grades 1-3 spent 5 hours in this self-contained VH classroom. Thus, by Year 1 of the project, the Madison schedule had been successfully worked out to accommodate project demands for two hours of ICTS mode behavior on primarily academic subjects. This factor plus subject continuity and the small size of Group 1 help to account for the high degree of stability in behavior between years. To an extent, we found the same trend at the Killian site between Years 2 and 3.

The situation at Killian was, however, much more complex. As analysis of mode behavior indicated, there was a significant inverse shift between Years 1 and 2 with respect to non-ICTS and ICTS modes. As stated, Year 2 was the first complete academic year of implementation for Group 2. Installing the ICTS at Killian during Year 1 was chaotic for both students and teachers. Without question, any major intervention of this type should be begun, as it was at Madison, during the summer months, with sufficient time for the teachers to be trained in its use and to become familiar with the system's varied operations. It took longer to get going at Killian, because these conditions were not met. Yet another confound at the

beginning of Year 2 was the division of Group 2 into younger and older subjects--a not insignificant change, particularly from the teachers' perspective.

Among the non-ICTS functional variables, observed non-ICTS behavior was significantly greater during Year 1 primarily because of the late implementation of the ICTS. (Although we cannot technically say that waiting behavior was significantly greater in Year 1, the fact that the mean percentage moved from 3 to 0 percent is at least a shift in the desired direction.) For similar reasons it is not surprising that ICTS functional variables show a significant percentage increase during Year 2. Although there was no significant shift in w/ADULT behavior, the change in means from 8 percent in Year 1 to 14 percent in Year 2 suggests an increase similar to its companion ICTS functional variables. By Year 3, waiting and off-TASK behavior had stabilized so that there were no significant changes.

Because it reflects an important difference between the younger and older groups at Killian, "w/ADULT" deserves special mention. Although there were no significant differences between Years 1 and 2, or Years 2 and 3, w/ADULT behavior was significantly greater in Year 3 than in Year 1. Examining the mean percentages in Table 6.5, particularly those for Group 3 (younger subjects) and Group 4 (older subjects), reveals a large percentage difference between the two groups, with the younger subjects requiring considerably more one-on-one adult supervision than the older subjects. Again this result was expected. Regular teacher aides, plus junior and senior high school student assistants, would normally work with the younger students in both ICTS and non-ICTS modes. In contrast, very often the teacher in charge of the older group was the only adult supervising them. In fact, the older students were notable in their ability to work on their own *un*supervised.

<u>OnT/onS, onT/offS</u>. What remains to be discussed are the two functional variables denoting direct subject use of the ICTS. The main goal for classroom observation was to provide descriptive data concerning the rate of task participation in terms of the different

modes and functions. However, early in the project some of the visitors to the two sites expressed concern that students would become dependent on the ICTS and consequently would have even more difficulty matriculating and/or mainstreaming into a regular classroom. These visitors made such comments as: "Well, what happens when they leave the system?" or, "If they need the ICTS to do reading and writing, then how can they read and write without it?" From the project's point of view this was never an issue. From the beginning, we saw the ICTS as a tool through which severely visually impaired students (excluding the functionally blind) could train their residual vision* to the extent that, other factors equal, they could overcome previous learning deficits and approach grade normal performance.

Such an expectation is an oversimplification. However, all subjects were well below grade normal at the start of the project, and by its end, as we have seen, the majority of the subjects were approximating grade normal performance in academic subjects. There is, however, another indicator, and that is the relationship between onT/onS behavior and onT/offS behavior. We hypothesized that over time these two variables would vary inversely: at the project's start, mean percentages were expected to be significantly higher for onT/onS than for onT/offS. This hypothesis is premised on two factors which underlie the interaction between the student and the ICTS.

First, all of our subjects can see. Moreover, all of our subjects appeared to have some degree of eye-hand coordination. The eyes of partially sighted subjects would "naturally" follow what the hands were doing, like their fully sighted peers. However, during work at an ICTS station the eyes do not follow what the hands are doing, at least not directly. When the system is being used, the eyes are on

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*Seeing is largely a matter of inference, even for the normally sighted. After learning to recognize letters and numbers highly magnified, subjects could "see" them even when the characters were made much smaller (Haber, 1969).

the student's monitor, while the material being displayed is somewhere else (e.g., on the student's desk). Consider the simplest case, the ICTS individual mode: the materials of instruction are on the X-Y platform, but what is seen is on the monitor. To read or write that way is "unnatural"; it feels awkward. Of course, students largely overcame this feeling of awkwardness; but nonetheless, given the opportunity and required acuity and field, they preferred to look directly at the book, a paper, or other instructional material.*

Second, the ICTS embodies the main principle of a individualized CCTV system in that the camera with zoom lens capability transmits a highly magnified image to the student, the zoom lens allowing for degrees of magnification of elements within the image. We assumed that in the beginning students would require a higher order of magnification, but as their ability to use residual vision developed and they learned to make appropriate inferences, they would be able to decrease the size of the elements within the image and thereby increase the amount of information that could appear on the monitor's screen at a given moment. Although we did not systematically test this behavior, we observed its occurrence, particularly with those subjects who had the lowest measured acuities. For these students, the change in size of characters was most dramatic.

These expectations had implications for observed behavior. At project start we would expect significantly more on-TASK/*on-SYSTEM* behavior than on-TASK/*off-SYSTEM* behavior, when students were beginning the process of training their residual vision; in short, they would be more dependent on the monitor's image despite the awkwardness entailed. Then, as residual vision developed, we would expect increasing on-TASK/*off-SYSTEM* behavior; given the gradual reduction of image magnification which would allow for a return to the more "natural" mode of looking directly at the stimulus materials when those materials were

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*In this context, what is "natural" or "awkward" is largely a matter of previous experience. Students' abilities to perform onT/offS depend on the parameters of their visual impairments and the extent to which they have trained their residual vision over time. Some of our students will continue to require the magnification provided by an individualized CCTV or large print materials.

located at the students' stations. (The key to this process is use of residual vision. Before the ICTS intervention, VH training for these students paid little attention to residual visual capabilities, in favor of more tactually oriented learning processes.) In relation to onT/onS and onT/offS variables, we first compared the two sites (from Table 6.7); then we looked at the longitudinal direction of change for each site (from Table 6.8); and finally, we combined the two sites to test for the relation between these two variables, as shown in Table 6.9. Comparing Groups 1 and 2 during Year 1 (Table 6.7) shows the Madison site with significantly more ICTS on-TASK behavior, both on-SYSTEM and off-SYSTEM. Year 2 shows the converse relationship, in part because the Madison site remained stable between Years 1 and 2 and the Killian site moved from partial use of the ICTS during Year 1 to full use for Year 2. Further, when we examine each group longitudinally (see Table 6.8), we note the stability of the Madison site; in fact, there is only a 1 percent difference for each of these variables between Years 1 and 2. The Killian site came closer to showing the shift, although Year 2 percentages were significantly greater than Year 1 percentages for <u>both</u> variables. However, in comparing Years 2 and 3, we note a dramatic decrease of onT/onS behavior ($p < .01$), and a corresponding increase of onT/offS behavior ($p < .01$). If we now combine both sites, as displayed in Table 6.9 below, we obtain further confirmation of our hypothesis. (Table 6.9 includes mean percentages to show direction of significance.)

The relationship between Years 1 and 2 for the combined sites reflects the analysis reported above for each site. The relationship between Years 2 and 3 is somewhat complicated, because Year 2 combines both sites, and Year 3 covers the Killian site only. Variable onT/offS shows the significant increase as predicted; there is, however, no significant decrease in variable onT/onS between Years 2 and 3, although the mean percentages show a shift in that direction. Finally, when we compare the combined groups for each year, we note a relative increase in onT/offS behavior; however, there is no corresponding

Table 6.9

ROS FUNCTIONAL VARIABLES: BETWEEN ON TASK/ON SYSTEM AND ON TASK/OFF SYSTEM

Variable Name	Group	Year	Mean	T	Significance
on T/on S	1,2	1	.16		
on T/on S	1,2	2	.33	4.45	$p < .01$
on T/off S	1,2	1	.06		
on T/off S	1,2	2	.11	2.97	$p < .01$
on T/on S	1,2	2	.33		
on T/on S	2	3	.25	1.31	n.s.
on T/off S	1,2	2	.11		
on T/off S	2	3	.29	5.10	$p < .01$
on T/on S	1,2	1	.16		
on T/on S	2	3	.25	1.95	$p > .06$
on T/off S	1,2	1	.06		
on T/off S	2	3	.29	6.57	$p < .01$
on T/on S	1,2	1	.16		
on T/off S	1,2	1	.06	4.74	$p < .01$
on T/on S	1,2	2	.33		
on T/off S	1,2	2	.11	6.26	$p < .01$
on T/on S	2	3	.25		
on T/off S	2	3	.24	0.70	n.s.

decrease in onT/onS behavior. This analysis, then, only suggests a confirmation of the expected behavior over time: that as residual vision was trained using the ICTS, subjects (who were able to do so) tended to become less dependent on the monitor's image, relying more on their newly trained ability to perceive stimulus materials directly.

In sum, we found that ICTS students were on-TASK 84 percent of observed time; this high level of on-TASK behavior can probably be attributed to several factors, not the least of which may be the intrinsic enjoyment of visually mediated learning experiences as well as a very small student-teacher ratio. The functional behavior of Madison students during the three year project was remarkably stable, largely because this group had had more extensive experience with the ICTS. At Killian, where the ICTS was installed in the same month when

ROS observations commenced and where students were divided by age group in Year 2, results were more complex: ICTS functional behavior increased (as students and teachers became more accustomed to using the system), and "with ADULT" behavior was significantly greater in Year 3 than in Year 1 (primarily because adults frequently worked one-to-one with the younger students). Killian results also suggested that at least some students were gradually becoming less dependent on the ICTS system; the system seems to have enabled them to develop residual capability so that they could see instructional materials with progressively less magnification (and in some cases, with no magnification at all). These results were not as apparent at Madison because behavior in the first generation site had largely stabilized before our observations began.

CONCLUSIONS AND IMPRESSIONS

Our observations yielded data showing that students were using the ICTS more than half of the time (on the average), and that nearly all ICTS time was spent on-task. Between-group and between-year differences largely reflected two general themes: stable behavior patterns representing incorporation of all ICTS features into classroom routines require at least a year of experience; and older and younger students' behaviors require different task structures.

When we combined ICTS and non-ICTS behavior to look at functional variables, we found that overall, students were off-task only 16 percent of the time. We also determined that as students used the ICTS over a long period of time, they tended gradually to become less dependent both on their teachers and on the system, and to spend more of their time working independently on-task but off-system (i.e., perceiving instructional materials directly, without the magnification provided by the system). We found no evidence that observer attention was in any way responsible for positive results. On the contrary, potentially disruptive classroom visits and even filming sessions seemed to have little effect on the students' behavior.

Having examined systematic observation data to learn about the impact of an ICTS on classroom behavior, it is appropriate that we supplement such information with an informal account based on observer impressions of the intervention. Most significantly from the observer's viewpoint, subjects could be seen reading (or recognizing letters), writing (or drawing letters), or working with numbers--tasks which, without the system, they could not do or could do only with great difficulty. During the first project year, the ICTS had an apparently different role in the two sites. At Madison, the first-generation ICTS was clearly integrated into that classroom's ecosystem; it was used by both the teacher and the students so that not only could (most of) the students habitually adjust their own TV camera, station monitor and writing platform, the older students could manipulate the system's master control unit--that unit that governs the interactive capabilities of the system. The key word is "routine"; sophisticated electronic equipment had become assimilated with the learning environment, in part a consequence of the infrequency of hardware problems. At Killian, the second-generation system was clearly not integrated during its less than six months of operation for the first project year. It remained new, fascinating, and disruptive. In other words, both the hardware and the people (students and teachers) had to be "broken in." There was a continuing series of minor hardware problems and anomalies; students were learning to use the equipment; teachers were continuing to learn, to explore the capabilities of the system, and at the same time to integrate their curricular material with the ICTS in an actual classroom environment.

These differences were accentuated by differences related to the constraints provided by physical site features. Madison was cramped, jammed with equipment. Consequently the students were generally quiet; there was little space in which to move about. These spatial limitations also required careful scheduling. Students had to be either at an ICTS station or a pre-designed activity center. Transitions between activities were smooth and well organized, reflecting a previous year of system experience involving four continuing subjects (out of five).

Killian, in contrast, was wide open with a lot of room unoccupied by equipment. It was generally noisy, with a high level of movement--three to six different groups could typically be observed at the same time. In short, very little was routine at Killian during the first project year when the system was in process of being integrated into classroom behavior.

As Year 2 commenced, there was no change at the Madison site; to the first year, the ICTS became fully assimilated; the equipment Killian site that the most dramatic change was observed. In contrast with the first year, the ICTS became fully assimilated; the equipment was no longer the focal point, as it had been during implementation; hardware problems* were far less frequent and considerably less disruptive when they did occur. Otherwise, the two sites retained their identity, determined by differences in number of students, amount of classroom space, and duration of the class day. In short, it was business as usual at both sites. During Years 2 and 3, new students at each site were integrated with ease. Teachers, aides, and, in particular, peers assisted each incoming student in the operation of the ICTS. In time, most of the students were able to operate the remote control for the room camera, as well as most functions of the control console.

To some extent perceived differences are reflected in initial between-site comparisons of cognitive and affective test results as well as in observation data. These differences were expected. However, both the observation data and pre-post outcome measures show an interesting similarity of pattern over time. That the ICTS yields such similar results in varied and dissimilar environments is, we believe, strong evidence for its effectiveness as an educational intervention.

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*In general, hardware problems consisted of: (1) realignment and synchronization of system components; (2) faulty cable connectors; and (3) burnt out station lamps. To a certain extent, electronic components require a "settling in" period after which standard maintenance suffices; cable connectors and light bulbs were easily replaced. In fact, after implementation, both systems continued to be remarkably trouble-free.

These reflections have led us to conclude that implementation of an ICTS system can be initially extremely disruptive to the existing ecosystem of the classroom. Generalizing from our experience, we suggest that the implementation process should occur in two phases. Phase 1 involves teacher training on the ICTS, preferably at the actual site but before the opening of the school year. Teachers need to explore the systems' capabilities on their own and to determine where they are having problems working with the equipment. In addition, the teachers are confronted with an entirely different system of presenting curricular materials. At the same time that they are learning how to use the system, they are obliged to adapt their materials to the interactive capabilities of the system; and, to a large extent, this adaptation is left up to teacher initiative and imagination. Finally, solution of hardware problems during this implementation phase should be carried out when class is not in session to prevent disruptions of classroom activities. Phase 2 occurs when school opens, and involves introducing the system to students and others who make up the specific ecosystem. It is probable that this time will be the most chaotic. Students must be taught how to use the equipment; curricular materials, developed in phase 1, are being tested and modified in phase 2; and finally, visitors (official and unofficial) are given demonstrations of the system. There is no getting around phase 2; however, "forewarned is forearmed"--perhaps the trauma of this phase can be reduced. At the close of phase 2 the system is implemented and has become assimilated with a site's ecosystem; in short, its operation has become routine. Full incorporation of the ICTS, based on our experience, could be accomplished in considerably less time than one academic year. In fact, what we have called phase 2 of implementation may take no more than a few months, depending on the size of the class, the capabilities of the teachers, and given that phase 1 occurred before the beginning of the academic year.

Finally, several general concluding impressions of students in an ICTS classroom deserve special mention. First, without exception, students mastered the operation of their ICTS, including learning to adjust the system to meet their individual needs. For example, as students completed an interactive group task, prior to transition to

another task, they were encouraged to work individually on previous assignments in progress. In most cases, students would proceed to the master control unit and shift their station from group to individual mode without interfering with the ongoing group activity. Second, students at both sites exhibited autonomous learning behavior to a remarkable degree. At Madison, for example, when students completed an ICTS task in the individual mode, they would then have their work checked and proceed to an activity center of their choice. At Killian, the older students engaged in autonomous group activities. At their own initiative, they produced a stage show for the younger ICTS students, students from the adjoining VH resource room, and the adults (teachers, aides, secretaries, and others). The older group wrote the script, choreographed dance numbers to recorded music, and designed and produced the background "sets." This was their idea: work on the production took place during the students' free time, and teachers played no role except to give their permission to do the project. Other examples of autonomous group activities include working on joint art projects and practicing together on musical instruments (recorder and harmonica). Again, these activities were self-initiated, unsupervised, and uncharacteristic of the students' fully sighted peers. (Many additional examples of classroom activities are provided in excerpts from teachers' logs, appearing as Appendix A.) Third, interactions with other students on the playground appeared normal, so that from the observer's viewpoint ICTS subjects were behaviorally indistinguishable from their fully sighted peers.

VII. CONCLUSIONS

The three-year assessment of project outcomes shows that an ICTS has strong positive effects on the educational experiences of a sample of partially sighted elementary school students. With respect to *academic achievement*, examination of standardized test scores showed that there was significant improvement in both reading and mathematics during all three project years. In the first year, students showed more dramatic improvement in mathematics than in reading; in the second year, reading scores increased markedly, so that no substantial differences remained between the two achievement areas; and by the end of the third year, students had made such substantial gains in both areas that they were performing approximately at grade-normal levels, even though they had begun the project with scores far below grade norms. As we have noted, overcoming such discrepancies requires students to make advances during the school year that exceed in a nontrivial way the estimated normal gains for fully sighted students. Finding that long-term exposure to an ICTS can close the achievement gap between partially and fully sighted students is particularly remarkable because without the ICTS intervention this gap would be expected to widen rather than narrow with advancing grade level. Not surprisingly, discrepancies between obtained and grade-normal scores were initially greatest for older students, even though the older students also made the largest gains toward grade-normal scores so that significant age differences did not persist. Both longitudinal and within-year results indicated that early ICTS intervention is probably most effective in preventing academic deficits related to visual impairment.

In the area of *achievement-related visual skills*, results were positive and similar in pattern. Students made strong progress in visual motor integration, notably in both within-year and longitudinal analyses. Further, longitudinal analyses showed significant decreases in the distance between obtained and developmentally expected scores, even though students had not reached age-normal performance by the end of the project. In large measure, the discrepancy was attributable

to older students, who began and remained a greater distance behind norms than the younger students. With respect to visual sequential memory, only the second project year produced substantial gains, and these gains were found primarily among the younger students. Such results again underscore the importance of early ICTS intervention. Longitudinal as well as within-year analyses of visual skill scores suggested that improvements in visual-motor integration, like mathematics gains, begin early in the intervention and continue at a more-or-less regular rate. Sequential visual skills like those involved in reading and in the visual sequential memory test start showing most dramatic changes in the second participation year; a very strong correlation between ITPA and CTBS reading scores in Year 2 corroborated this finding. We concluded that perceptual motor skills are probably linked to information reception and production in more noticeable ways for severely visually impaired students than for fully sighted students. Although some level of visual skill is required for reading and mathematics achievement, it appears that age-normal functioning is not a necessary condition for grade-normal academic achievement.

Psychological dimensions of school experience, constituting the third evaluation area, provided less evidence of systematic effects. For example, although students' achievement improved remarkably during the project, their attitudes toward test taking remained distressingly consistent and negative; the failure experiences accumulated by many of these handicapped students in test situations may have created evaluation apprehensions that are difficult to overcome. A somewhat more promising set of results emerged from self-oriented attitude measures. Both verbal (SOS) and nonverbal (SSCT) assessments suggested that students were developing more favorable self-constructs during the project, an outcome primarily explained by positive changes in older students' scores; however, scores for all grade levels were above national norms on the SOS measures. In addition, extensiveness and closeness of peer contact (SSCT) seemed to be increasing, particularly among older students. In contrast, school affiliation scores (SOS) declined over time, especially among younger students. These

latter findings raise questions about school-relevant social attitudes among the younger visually impaired subjects. It is possible that the outcomes reflect method bias, because the strongest grade-level effects are generated by the verbal instrument and it is the older subjects who are better readers; however, the nonverbal SSCT tends to corroborate grade-level differences, suggesting that verbal method bias could provide only a partial explanation of results. Another interpretation is suggested by scores on the SOS measure of social maturity. As we pointed out, increased social maturity cannot be attributed to the ICTS intervention; but the scores show strong stable effects in the expected direction, lending some confidence in that measure. ICTS students at younger grade levels attained scores on this dimension over two years of the demonstration that were more than a standard deviation below the grade-level norm (see Table 5.11). It is possible that for less mature students the social environment of the school is more stressing, resulting in lower outcomes on other socially oriented attitude dimensions. In any event, these results suggest that special attention should be given to the socioemotional climate in the classroom for lower-level handicapped students. Finally, in the area of affect encoding, we found that students in the site II classroom, where teachers emphasized facial affect communications during the last year of the demonstration, improved markedly during that year. Partially sighted students' post-test scores approximated scores obtained by the fully sighted control group. This finding seems to indicate that with proper classroom experiences, severely visually impaired students can learn to encode facial affect appropriately and can thereby increase in social competence.

Observations of *classroom behavior* showed that the ICTS intervention, which radically changed the ecosystem of classrooms both physically and socioemotionally, was met with eager anticipation. Motivation to use the system appeared to be extremely high and was rewarded when the entire classroom, for the first time, was brought within the visual purview of each student. All students learned to operate the equipment safely and with relative ease in about two months. The teachers appeared to be equally delighted with the system, reporting

that they enjoyed exploring its capabilities. After the implementation stage, the ICTS was fully assimilated, becoming an integral and familiar part of the classroom routine.

Systematic (ROS) observations give support to these general remarks. Subjects spent half their classroom time using the ICTS. The strongest finding over three years of classroom observation was that subjects spent a very large proportion of their time in behavior appropriate to the teacher-specified activity in both ICTS and non-ICTS modes. We believe that the ICTS intervention mediated such behavior. We also found that use of the ICTS over time allowed students to train their residual vision and to make greater use of it in learning situations. This inference was supported in two ways: over time, subjects gradually reduced the magnification of the images on their monitors, thereby increasing the amount of visual information available; moreover, comparing the functional variables On Task/On System and On Task/Off System suggested that over time there is a decreasing reliance on the monitor's image in favor of looking directly at the material on the X-Y Platform. Using the ICTS to develop residual vision skills, then, permits subjects to decrease their reliance on the TV image for near visual tasks. We believe that learning to exploit residual vision in this manner enhances students' performance in regular classrooms.

In summary, the three-year demonstration project shows that the ICTS can create a viable visual environment, yielding positive classroom experiences for partially sighted students both academically and socially. These results, however, are based on a very small sample. We do not claim that our findings can be generalized to all partially sighted students. However, the evaluation has established strong and stable ICTS effects on a variety of aspects of student learning in our sample. Because there is no reason to believe this sample to be atypical of severely impaired students in a manner that would interact with demonstration effects, and because there is strong reason to believe that access to visual information enhances learning, it is our conclusion that interactive classroom television systems could be of widespread benefit to partially sighted elementary school students.

RECOMMENDATIONS FOR FUTURE RESEARCH

As we carried out the three-year evaluation of the impact of the ICTS on the learning experiences of partially sighted students, we became aware of several areas that seemed to merit further research. For instance, in an effort to compare the progress of subjects in the ICTS demonstration with the academic advances made by severely visually impaired elementary school students in other types of programs, we were surprised to learn that achievement data have not been systematically collected for this population (cf. Kakalik et al., 1973). Further reviews of relevant literature in fact seemed to indicate that very little outcome research is undertaken with respect to visually handicapped students either for increasing basic knowledge or for purposes of program evaluation. We strongly recommend that a variety of outcome research be carried out with such students in order to better understand their capabilities and--more importantly--to provide for judgments about the relative educational effectiveness of different programs.

Although normative data are not available, it is generally assumed in special education literature and by special education teachers that partially sighted students will inevitably fall behind expected grade-level performance. While achievement scores initially attained by ICTS students were in fact substantially discrepant with grade-normal scores, their progress in overcoming the discrepancy suggested to us that a well-designed demonstration program might be able virtually to eliminate the gap--especially for younger students and especially in the area of mathematics. In the table that summarizes the longitudinal analysis of distances between obtained and grade-normal mathematics scores (Table 3.14) it is apparent that younger students are not initially behind and that the discrepancy reduces to zero by the end of the second participation year. It is our belief that a curriculum giving very concentrated attention to arithmetic and underlying skills in the beginning grades (where the emphasis is more typically on reading and language skills) might establish that mathematics achievement deficits could be eliminated. While reading

appears to pose greater difficulties for partially sighted students, we suspect, on the basis of our study, that efforts directed toward teaching scanning, visual search, and visual recognition strategies as early as possible in the students' school experience would be reflected in improved reading achievement. Such possibilities deserve further exploration.

Observations of students during learning activities as well as our evaluation results tended to support our conjecture that perceptual and motor skills are extremely important in the acquisition and transfer of information for the severely visually impaired. Although students may be cognitively fully competent to master academic tasks, the media through which such mastery is gained and demonstrated present serious barriers. In our view, therefore, it would be desirable to give some basic research attention to perceptual and motor processes among partially sighted subjects in experimental efforts that are not necessarily tied to school curricula or programs for the handicapped. To our knowledge, little work in visual information processing, eye-hand coordination, and related fields has been done with subjects for whom only limited residual vision is available. Consequently, it is not known to what extent such skills depend on acuity, to what extent they can be learned by low acuity subjects, and so on. Research of this nature would contribute to knowledge about vision-related skills in fully sighted subjects and provide a foundation for understanding and potentially improving the performance of severely visually impaired students.

Investigating psychosocial dimensions of school experience among partially sighted students in the ICTS demonstration posed two kinds of problems that we thought indicated needs for future research. First, as our discussions of results in this area indicate, we were not confident about the robustness and validity of the measures we were using. However, we had done a fairly extensive literature search and could find none that we believed to be better. It therefore seems worthwhile to undertake either the development of a new instrument or the validation of existing instruments for assessing self and social constructs in handicapped elementary school students. Ideally, the measurement

procedure should be nonverbal because these subjects may be expected to be less fluent and less proficient in reading than their fully sighted age-mates. Second, an examination of psychosocial outcomes over three project years together with achievement data led us to be skeptical about hypothesized links between them. That is, measurement problems notwithstanding, we were doubtful whether school achievement could be expected to account for much variance in the socioemotional world of handicapped students. Rather, given remarkable advances in reading and mathematics and only small noncommensurate changes (if any) in psychosocial responses, it seemed likely that there were other important determinants of self and social constructs among our subjects and that such determinants should form the focus of future research. Informal observation led us to believe that the components of social competence would be one important class of determinants, and we pursued some exploratory activities in this area. As Sec. V explains, we believed that facial affect encoding and decoding were probably significant components of social competence and that these skills were underdeveloped in our subjects. While the former thesis remained an assumption, we were able to determine that at least with respect to facial affect encoding, our subjects performed substantially worse than fully sighted matched-control subjects. On the basis of this finding, a curriculum strategy was developed to teach such encoding skills, and within an academic year ICTS subjects were performing comparably with same-aged controls. We recommend that research of this sort be conducted in relation to a broad range of factors (other than academic achievement) that potentially underlie socioemotional dimensions of school experience for handicapped students.

Finally, because of the heterogeneity of handicapped students, together with the restrictiveness of standardized measuring instruments and observations, we suggest the advisability of considering an ethnographic approach* to understanding the impact of special education

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*By an ethnographic approach, we mean an observational study that is less structured and less formal, collecting a broad range of information that will shed light on the classroom ecology. Such approaches are more commonly used in anthropological and sociological field studies.

programs. While we do not believe that ethnographic methods should substitute for outcome research, we believe they could be a valuable supplement to standardized data collection and would contribute significantly to information about how handicapped students experience school. Studies of this sort are especially recommended for comparing the social-psychological environment of handicapped students in regular classrooms, in self-contained special education classrooms, and in settings that include both sorts of classrooms at different times for different subject matters. We believe there is a great deal to be learned about the social and emotional context of school from the perspective of the handicapped elementary student.

POLICY RECOMMENDATIONS

Four years of on-site operation of the ICTS, including three years of systematic evaluation and observation, have provided the basis for a number of recommendations that are coherent with current policies regarding education for the handicapped. Public Law 94-142 mandates that every handicapped child receive an education comparable to that received by their nonhandicapped peers. In particular, each handicapped student is to be assessed for placement in the *least restrictive environment* appropriate to that individual. The least restrictive environment for any given partially sighted student, who may or may not have other handicapping conditions, can involve either continued enrollment in a VH classroom, partial integration into a regular classroom along with appropriate VH resource assistance, or full integration into a regular classroom if low-vision aids can be found that will provide full visual access to classroom learning opportunities. With these general considerations in mind, we make the following specific suggestions.

1. In order to assess what type of environment will be visually least restrictive, every partially sighted child should have a thorough low-vision evaluation annually carried out by a low-vision specialist, i.e., an ophthalmologist or optometrist who has had special training in low vision. We further believe that the

cost of these examinations should be borne in full (or in part, in line with a sliding-scale fee schedule) by federal, state, or local agencies. Our experience strongly suggests that visual examinations by individuals other than low-vision specialists are inadequate as a basis for determining the functional capability of residual vision, or for prescribing appropriate low-vision aids and training in their use. The ophthalmologic and optometric community currently stresses the need for annual visual examinations for fully sighted persons; with partially sighted students the need for an annual low-vision evaluation is all the greater, given the likely potential for visual changes that could seriously alter functional capability.

2. Even though standardized achievement test data for partially sighted student populations do not appear to be available, it is generally believed (and it is likely true) that most severely visually impaired elementary school students, *without other learning disabilities*, perform well below grade level and that the discrepancy increases with age. Consequently, prior to being placed into regular classrooms, partially sighted students must be provided with basic academic skills so that they will be able to achieve at a rate comparable to their fully sighted age-mates. Our evaluation results strongly suggest that access to an ICTS allows severely impaired students to avoid or to overcome deficiencies in achievement and related visual skills so that they are able to make academic advances appropriate to their age. Since the ICTS is currently on the market,* but since the cost of an ICTS (see

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*All components of an ICTS, except the master control unit, are currently on the market. Design details of the master control unit are currently in the public domain and available through The Rand Corporation. Production of the unit would require a moderate level of technical sophistication on the part of the manufacturer.

Appendix B) is likely to prevent a manufacturer from producing the system without some financial guarantee, we recommend that a number of regional centers be established in sizable U.S. school districts, with those agencies involved in education for the handicapped underwriting the cost of their establishment. The regional centers would not only serve partially sighted students in that immediate area, but each would also be a demonstration and (potential) training site for other VH personnel in that region. Given the population statistics for partially sighted persons nationwide (Genensky, 1978), any community with a minimum population of 100,000 is likely to have partially sighted students in sufficient numbers to justify the establishment of an ICTS in that community. We estimate that a manufacturer would need an initial guarantee of at least 10 systems before undertaking their production.

3. Satisfactory mainstreaming of partially sighted children into a regular classroom on a part- or full-time basis will require as complete visual access as possible to that environment. With or without previous ICTS experience, most partially sighted students will require portable optical or electro-optical aids in order to achieve visual parity within such a classroom. Portable low-vision aids range in cost from several dollars for a simple hand-held magnifier to approximately $1500 for a portable CCTV, a unit that could be transported from classroom to classroom or from home to school. Many families of partially sighted children cannot afford the cost of these aids, and unlike clients of vocational rehabilitation agencies or veterans who qualify for Veterans Administration aid, visually handicapped students are given no provisions for third-party payments for low-vision aids. We therefore recommend that local school districts be provided with state or

> federal funds to purchase these aids for loan to partially sighted students for their use both in class *and* at home. (Ideally, parents of partially sighted children should have their own access to third-party payments.)

Finally, it is clear that PL 94-142 represents a mandate for full educational opportunities for handicapped students. In the case of the severely visually impaired, advanced technology has established the avenues for their access to visual information in learning environments. What remains is for public funds to be specifically allocated for these purposes.

Appendix A

TEACHER LOG EXCERPTS
(1974-1978)

In addition to observer impressions (see Sec. VI), we obtained information on teachers' perceptions of ICTS incorporation in classroom behavior by examining the daily logs that teachers were asked to keep throughout the project. These informal records are in themselves of considerable interest: they give a good indication of individual students' progress in using the ICTS to learn new skills, the general atmosphere of excitement and motivation that characterized ICTS classrooms, and the ingenuity of the teachers in finding new applications for ICTS equipment. Rather than describing at length the material found in the teacher logs, we have decided to reproduce substantial portions of the logs, so that interested readers can share our access to the teachers' own words. For reasons of confidentiality, first initials have been substituted for names of students or other individuals identified in the logs. Although evaluation began with the 1975 academic year, we have included abstracts from the Madison log for 1974-75 for the rich descriptions provided of the first year of ICTS use at the Madison site.

TEACHER LOG - MADISON

1974 - 1975

9-19-74

I worked with each student to determine his/her proficiency using the ICTS. I gave intensive instruction to C, one of my new students. He caught on very quickly, and he began to practice reading and writing using his ICTS. The rest of the class remembered most of the procedures while using their ICTS, but some of them had forgotten how to adjust the contrast and brightness knobs and where they were located.

9-20-74

The group lesson during reading proved to be very successful. If a student had difficulty spelling a word, I would project one of his classmates' answers on his monitor. This enabled him to see the correct answer and write the correct answer on his monitor.

9-25-74

During Reading I worked with 2 students. I would show them a picture on the TV and ask them to tell me what was going on in the picture. As they described the action, I wrote down their words in simple sentences. We cut the words into square shapes and we practiced placing the words in the proper sequential order.

The class can work independently in their workbooks at this time. Each student can successfully complete 3 pages during the 15 min. intervals. This is something that some of my students had difficulty doing last year.

9-26-74

I used the split image during this reading lesson. I used the upper half to produce 2 pictures. Each student was asked to write yes or no in their monitor. Yes indicated the pictures began with the same letter and no indicated they did not.

9-27-74

The class practiced their cursive handwriting. I used the overlay so that the students were able to trace over the letter or letters that were shown from my monitor. Most of the class need drill and guidance in their letter formations. Many of the students have a form constancy problem (great variability in size and shape) and a few have a spatial relations problem. These problems are evident in some of their visual-motor tasks.

9-30-74

During the reading lesson, I used one of the puppets to motivate the class. The puppet introduced new words on the ICTS to the class, and then asked the students to recall each word. Most of the students had good visual memory but one student could only recall one of the words.

I have noticed that if a lesson is too difficult for any of the students they begin to lose interest in it. This happened during the reading lesson, and resulted in complaints from one of the students.

10-1-74

Two students worked together during reading. S used my monitor to show another student a list of words which contained missing letters. The student was asked to fill in the missing letters, and S checked their work.

10-2-74

I gave the class a completion task which involved completing a picture of a lion. I used the overlay (teacher/student) and each student traced the image and added to the lion. One problem with the tracing task is that some students require a different magnification in order to see the image. The problem occurs when you enlarge the image because you may lose part of the field or picture. By raising the lens on my monitor I was able to enlarge the picture without losing parts of the lion.

10-3-74

The class is becoming more independent, and each student is able to start his/her task without much direction.

10-4-74

As a group, we examined the one and five dollar bills on the ICTS. I asked the students questions concerning the bills and then we made different combinations with coins that equaled one dollar. The students enjoyed examining the bills on their monitors. Some of the students decided to trace George Washington from the one dollar bill.

10-7-74

I read with each student and I pointed out different punctuation marks. When we were finished, I wrote a sentence on my monitor without punctuation. I then placed a period at the end of the sentence. I changed the punctuation to an exclamation point and question mark and asked the student to read the sentences again.

10-9-74

I tried a new lesson with the class which works well on a one-to-one. I would place a word on one of the student's monitor and I told him/her that the word would disappear in 10 seconds. As I moved the X-Y Platform the word would slowly disappear. The student would try to say the word before it disappeared. T particularly enjoyed this game although he had some difficulty with the words.

10-23-74

I allowed T to select a reading book and he chose a book about dinosaurs. I am so impressed with his progress. He is so excited about this book, and his reading efficiency has improved. He is reading more words per minute and he's recognizing the sight words. When he finished his reading, he always draws pictures of the dinosaurs or acts out parts of the story with the puppets. I have a whole stack of books about monsters, fish and animals, and he can't wait to read them on his monitor.

10-24-74

N gave a group lesson on nonsense sentences. She read the class a nonsense sentence and discussed it with them. Then she asked them to write one. I observed--for a change, N is becoming more familiar with the machine and seems to enjoy using it.

10-25-74

I placed an outline of a pumpkin face on my monitor. Using the overlay the class drew their own pumpkin faces with black marking pens (on orange construction paper).

During reading, we read some cartoons on Halloween. The class helped me to read them. When we were finished, the class made up their own cartoons. We used the overlay to draw the cartoons.

Using dominoes placed on my platform, the class worked several addition and subtraction problems. The dominoes showed up very well in both the positive and negative.

11-5-74

The class made designs out of toothpicks. Using their ICTS, they were able to make intricate designs.

11-13-74

I gave the class certain shapes and figures to imitate or copy. Most of them could complete the task, but A had difficulty with some of the more difficult ones.

Example:

The class seemed very interested in some of the tools and machines a blind person might use. They asked many questions pertaining to certain needs of a blind person such as how do they tell time, how do they get dressed? Some of these questions are answered in our special lessons on daily living skills and others will be answered tomorrow. The class made a list of important questions to ask our tour guide.

11-22-74

I used the room camera to focus on a screen so the class could view a filmstrip on Thanksgiving. The class could view the filmstrip from their seats and it was very clear and easy to read.

11-25-74

The class viewed a display table with the aid of their ICTS. The table contained different materials to use to construct a papier-maché turkey. The class observed while N and I showed them the techniques involved in constructing their own turkey. When we were finished with the lesson, the class began to work on their own turkeys.

12-2-74

N worked with T and A using the flash cards. R worked independently in a workbook. N did not use the CCTV during her lesson with T and A, and T had some difficulty reading the flash cards.

After class, I pointed out to N that many times it is easier for some of the students to view pictures and flash cards with the aid of their CCTV. I encouraged her to use the CCTV during some of her lessons.

12-3-74

R's parents came at 8:45 for their conference. We discussed R's progress both in school and at home. I gave them pertinent information pertaining to his test scores and school work. They seemed very pleased with his progress and they commented that his attitude has changed due to the CCTV. He now enjoys reading more--and he even asked his parents for some large print books to read at home. His parents feel he seems generally more self-confident about what he can do!

12-10-74

I was working with T on short and long vowels using the anagrams. As I made words with short and long vowels, he decided he wanted to make some words for me to read. So I let him and he came up with a number of words with short and long vowels. As I went to check another

student's work, T put all the anagrams in alphabetical order using his CCTV. He felt very good about it, because he told me he couldn't see the letters without his machine.

1-6-75

I used the flash cards during Math. I used the ICTS to show the cards (split student and teacher).

I taped one of my lessons with T. We were reading a book that has pictures and words. T would help me read the words and we talked about the pictures. The book was so interesting that T wanted to play the tape back. It was such a good tape that I decided to use it as a lesson for A. He really enjoyed it. I feel this will be a great way to utilize the video tape and it will be a useful tool to teach some of the other students.

1-8-75

My class seems quite motivated by the video taping. They enjoy seeing and listening to themselves.

1-9-75

T and R have taken up an interest in clay modeling. Each of them have sculpted some unusual pieces which we have sent off to fire.

The entire class seems so happy and seems to have a positive attitude since the Christmas vacation. A is extremely attentive, and T and R have finished all their work. Both T and R have taken an extreme interest in many of the things in the room. They seem to explore more and want to try things on their own.

1-13-75

Using a picture of a head, I asked each student to draw the rest of the body. They could change the head to make it anything they wanted: a baby, a mother, a father, a dog, etc. The head was located at my monitor and using an overlay and student, the class drew their bodies.

We used a phonics book to play a phonics game during Phonics. This is one of the great advantages of using an overlay and student.

The students can view an original book of work--they can draw on it, fill it in, change it, etc., without altering the original.

1-14-75

I let the class view pictures of footwear, and we discussed what each person might be wearing. One picture was a picture of cowboy boots. After discussing the picture they used the over-lay to draw the rest of the body. The drawings were quite good.

1-17-75

The State Auditors came today to evaluate our programs. A woman named D came to observe our class. I had an opportunity to visit with her and get some feedback about her feelings and criticisms. She was very impressed with our program and she felt we were covering all the important areas pertinent to the VH. She enjoyed watching the class use their CCTV, and felt the group interaction was good.

I used the CCTV to show a maze. The class had to read the words in the maze and use their pencil to find a way out of the maze. They enjoyed this task and they squealed with delight when they found the path that led out.

1-30-75

We talked about how we are different from other people. Discussing their differences made them aware of themselves. When we were finished we traced our bodies on butcher paper and proceeded to color them. Each one took a different position and L decided he wanted to be sleeping.

T brought a book (he brought it from home) for us to share. During Reading, T and I read parts of the book together. It was a book on riddles and T enjoyed it.

2-7-75

The class continued to work on the stories they have been writing. They are so enthusiastic about their stories and are writing very interesting and original stories.

2-11-75

I read a poem to the class using the ICTS. We discussed different stanzas and the different parts of the poem.

I gave the class a short poem with missing words in it during our story-writing lesson. The class then wrote 2 lines of a new poem.

2-21-75

The class wrote the 7 days of the week. I feel their handwriting is improving and they are beginning to take pride in their handwriting. They are forming their letters correctly and they are paying closer attention to the spacing of their words.

2-24-75

R ran the ICTS, while I gave individual help during a Phonics lesson. The entire class can effectively run the ICTS, and I feel this is an important contribution, because it allows me to give individual attention to those who need it.

2-25-75

Using a variety of magazines, I worked with the class to identify and read different ads. We discussed the products and the purpose of advertising.

2-26-75

Using the Overlay-Teacher/student, the class viewed clocks and were asked to identify the time or to place the correct time in the clock. The class is now able to recognize 5 minute intervals on their clock and they can successfully recognize half past, quarter past, and the hour.

2-28-75

The class is still working on their books. L and A finished one story. We shared their stories with the class. A helped me read his story and he was so proud of the fact that he had written his own story. L wants to have his story published.

3-3-75

Using the room monitor (in a group) the class viewed 4 words on it. We reviewed the words and then the class (without their ICTS) wrote the words. Most of the students write the words and letters much larger when they are not using their ICTS.

I worked with T and A on reading traffic signs using the ICTS. I enlarged the signs so that T and A could read them. T could identify most of the words and he helped A read them.

3-5-75

The class always enjoys the opportunity to work at the board. Using the ICTS, the class can view students working at the board and continue to view the lesson at their monitors.

3-6-75

Today we had a special art lesson. The class observed pictures from magazines and were asked to examine different faces of people. We discussed the differences and then we cut out different parts of the faces to make new ones. We added arms, legs and clothes to make an entire new person. They turned out to be quite clever and fun for the students.

3-10-75

I feel at this time that the class has become quite proficient in the use of the ICTS. They now work independently and many times choose their own activities and books. They do not need much guidance at this point, and many of them can set up my station and work the room camera. At times, I allow the students to teach the lesson. The only complaint that the children tend to have is many times their large print books are so large that they become cumbersome to work with on their X-Y Platform.

3-11-75

T has been reading a story about sharks, so I brought in a replica of a shark for the class to view on their ICTS. By raising my lens up, the class was able to view the entire image of the shark. They became

quite interested in the shark and many of them asked to see the shark after the lesson. I asked S to read part of his story about sharks and the class listened and asked questions. S felt very good about his accomplishment--last year at this time, he couldn't read many words!

3-18-75

During individual reading, R complained that it was very difficult to maneuver his X-Y Platform with his large print book. This is a problem that we have come up against before. Little can be done to alleviate the problem, but if the student is aware that he may have to move the book around on his X-Y Platform in order to see all the print, then there will be fewer problems.

3-19-75

During Math, T helped me check the students' work while they worked on a group math sheet. Using the split image, I placed an object or picture of an object on the top half of the student's screen. Next to the object was the price of the object. I asked the students to write the amount they would have left if they paid for the object with a dollar bill.

4-1-75

We practiced our handwriting without using the ICTS. Most of the students have to get very close to the paper in order to see their work, but I feel it is important for them to learn to use whatever vision they do have--with or without their ICTS.

4-2-75

I observed the students' handwriting today and compared it with their previous work and there is a considerable amount of improvement. Most of their work is neater and the letter formation is better.

During Individual Reading, the class read the Sunday's Comics. They thoroughly enjoyed that.

Using the overlay (blackboard and student) I had the class view a worm that had words written on him. Each student was asked to read

the words--but I changed them to meet individual abilities. The room camera made the worm wiggle in different directions. Quite effective.

4-3-75

Using the split image (teacher and T) I placed coins on the upper half of the students' monitor and asked them to write the correct amount of money on their monitor. At first the coins weren't as clear as I would have liked, but when I placed a clear white sheet of paper under the coins, they appeared more clear.

4-4-75

The cooking lessons are so successful I don't know why I hadn't introduced them before. Not only do the students learn to read recipes but they also learn to measure and incorporate mathematical concepts. They also learn to differentiate between size, amounts of liquid, etc. Classification is also learned.

4-21-75

I noticed that T had less difficulty taking his test this time. He could identify most of the words and his reading speed has increased. He is much less frustrated than he was in the fall. And, he could finish his test in the allotted time.

I started S today, too. She seems to be eager to do well on her tests, too.

5-8-75

T decided he wanted to read his Science book on his machine, so I got a copy of it from his teacher. We read about the Solar System and T wanted to continue to read even after Reading I and II!

5-14-75

During Reading III, we shared a book that had a short play in it. I read the play then we acted it out (as a group). I used the room camera to focus on us, and I used the room monitor to watch the play. The class really enjoyed this and they watched patiently while the others performed.

5-19-75

I used the teacher's monitor to display a money tree with circles on it. The class was given play coins and were asked to fill in the picture of the money tree with the proper coins. They seemed to really enjoy this lesson.

5-20-75

R brought in 2 encyclopedias from his regular classroom to read using his ICTS, and T has been bringing cars and animals (plastic) to examine under his machine. A even brought a coloring book and looked at all the pictures in his monitor.

5-30-75

We read comics together on the ICTS. Afterwards the class made their own cartoons. We have tried this before, but the class enjoys reading them because they don't usually get a chance to read them (the print's too small).

6-2-75

Using the blackboard we drew tic-tac-toe but placed problems in them. The first person to complete a row correctly wins. I made this game up, and was not sure if the kids would enjoy it--but they loved it.

Example:

5×8	7+8	6×9
54÷9	36÷6	8+4
7×3	9×9	24÷3

You can alter the game according to the children's abilities.

6-3-75

R and I used the ICTS to study his Spanish. I used the split image to show the Spanish word and he would write the correct word in English. This proved to be quite challenging for him.

6-11-75

The class has not lost interest in their machines, and enjoy working with them every day. They realize how much the machines can help them, not only during Reading and Math, but also during our group lesson.

6-16-75

We used the ICTS to show words from some of the songs the students will be singing at graduation.

6-18-75

The class is finishing up their books. A has completed his second book along with S and L. R and T are panicked because they're not sure they will complete theirs. They asked if they could work on their books during free time. That surprised me, because they always enjoy their free time playing games or painting.

TEACHERS' LOGS - KILLIAN

1975 - 1976

11-26-75

28.3 RC 34.9 System. Our first reading! Yesterday it all came! We were stunned and the children were excited. The children made a row of chairs across the middle of the room and watched the installation as a form of entertainment. Many questions: When can we use it? Could we do our math, reading, etc.? Will we all use it?

D liked sitting at the station but did not want to look at her monitor. After some time she used the screen but began to like it only toward the end of the day.

12-1-75

D did her reading on 4 (i.e., at station 4) this morning. She seemed to very much enjoy using the ICTS and went on reading long after she had finished her assignment. She asked for her reading book when she finished her math in the afternoon and spent 30 min to 1 hr reading on 4. Monday, used the negative image for math and seemed to find a two-problem, three-digit size to be right for her.

E could not reach the X-Y Platform as he needed. He puts his face against the monitor surface and moves his chair around trying to reach his paper. We have to try and find the right height chair for him, the right combination of monitor and X-Y Platform location for him upon his return from County General Hospital.

J, seated at 1, preferred to face the back of the teacher's station. After some time he began to look at his own monitor. He was shown the manner in which an image might be traced, but had much difficulty locating the correct placement of his pencil on his paper. Once he had found their relationship, he was able to do a fine job of relating the pencil to the image. However, the pressure he applied was not enough to mark the paper and resulted in a blank paper.

12-2-75

H and J in room working. We used ICTS for Reading, Language, and Math. Children worked well with materials provided. The high motivation of the equipment has resulted in *all* the children being eager to do their assignments. The children spontaneously and without teacher direction found their math assignments and completed them (H the only exception). The microphones were high motivators and very valuable in interaction with the children. We found that by clipping the mikes to children's clothing communication was improved. General noise level in the room dropped. D, upon hearing her own voice, became shy for a short while and at first would not talk, but grew used to the new situation and became interested in its use.

12-3-75

We often have unhappy children when all stations are in use and there are more children than stations. Y had not used ICTS until today (HOT DOG). After several attempts to get her to look at the screen instead of the X-Y Platform, she was convinced she could work that paper better at a table.

12-4-75

Math and reading work okay so far, but we are still learning what sort of materials work best with the system.

12-5-75

J and R still looking at X-Y Platform instead of screen. J, K, and T still sliding paper instead of X-Y Platform.

Mrs. M called (12/2) to ask if she could take R out of school a few hours for his brother's Christmas program at school. She said she knew we had the new equipment and didn't want to take him away from the equipment. We assured her he would "make up" any time lost. Not sure what we meant by that, but it reassured her.

12-8-75

The children used the system for their morning tasks, some independent reading and their math papers. Today, for the first time, the system seemed to become part of the tools used in our classroom.

12-19-75

Territorial possession demonstrated by children. Each child recognizes a station as his/her own. Cooperation and sharing have taken place, but each child shows particular regard for one station.

The chief problem with the relation of children and system seems to come from those children who are not *on* system (i.e., who have not been assigned a station). Perhaps room monitor installation will solve this?

1-6-76

T asked if he could bring the books he got for Christmas to read on the system because he couldn't read them at home. Several children said they missed the ICTS over Christmas.

1-14-76

R taped L and younger ones doing a language lesson. We used a split screen showing the letters "O, N, E" and gave the children letters of their own to make their own "One."

1-28-76

B seems to find it difficult to recognize the image of his own hand on screen.

We are interested in watching the differences in the ways each child develops his/her own approach to writing on the X-Y Platform.

D moves off platform to table when having difficulty.

K attempts to put his head between lens and platform.

C still prefers to move paper rather than platform when writing.

All the above children seem to prefer platform without friction or margin limits, even though they have been introduced to methods of control.

2-4-76

(Entered by itinerant teacher, J-C)

I brought an itinerant student, B, who uses Braille, to read with the ICTS. He has really not seen print except for news headlines. He read his typed ancient literature final with no real problems--and saw the markings the instructor had written. He is very interested in music and had brought the small copy of the orchestral score of Beethoven's 5th. He was able to see this, using the dark background and light printing. We had worked a little on print music symbols previously, but he was able to quite quickly read the music, triplets, 32nd notes, etc. He was very pleased, as this was the first real music he had seen. Will continue in future sessions to work on reading and writing music.

2-11-76

It seems to us that the relationship of the children with TV in the "outside world" and in our classroom is different in several important ways: (1) outside - passive/ICTS active, (2) outside TV acts on person/ICTS person acts back, or with (3) learning in many non-ICTS lessons are passive/ICTS make it necessary for children to be active.

2-18-76

We are concerned that the children are not getting enough time on the ICTS. What can we eliminate in order to allow more ICTS time? Can we adapt some of the other learning activities to the equipment? What needs to be done by us to gain time for more frequent and creative use of the ICTS?

2-20-76

We think that it may not be to the advantage of the children or the teacher for the teacher to attempt to read a story from a TV monitor, as the reading speed that seems to be average for the teacher requires that the words move on the screen at a rate too great to follow with the normal eye. At first we thought that if we were to give the children their own copy of the text, they would be able to follow. However,

the same disadvantage persists. We now feel that the main difficulty lies in the fact that when a sighted person reads, h/she moves his/her eyes at the speed agreeable with his/her comprehension speed. ICTS requires that the letters move faster than can be seen (i.e., we think comprehension is faster than recognition for fully sighted persons). We are going to try paper mats and see if moving the book behind the mat has the same effect as U&R.

2-20-76

Taught time today, using small clock faces. Children counted by fives on a clock face with no hands, and then with clock hands, with small hand pointing to 12:00 and large hand to 5, 10, 15, 20, etc. minute positions. Used overlay and pointed as they (the children) counted, each child taking turns. Seems to be working well at this point.

2-24-76

Put Y, R, R, B, J, T, and S on ICTS. Displayed picture from page 1 of Fins and Feathers Workbook on all monitors. Began asking the questions and discoved I had to increase magnification. By zooming in on the part of the picture appropriate to the question, all children answered the questions correctly. A satisfactory reading lesson for the little ones!!

3-2-76

Used the reading from the Wizard of Oz. Again today the children seem to like the many optical effects and enjoy the story. This book seems to work with the ICTS because the whole book contains high contrast black/white images and letters.

3-11-76

Am going to try more children interaction in all aspects of all Language Arts lessons (this as a result of giving children cards). Children have more control, and letting them be on room camera and use language art cards on ICTS.

<u>3-13-76</u>

Mouth harp lesson on the ICTS today. D, C, T, used room camera to go back and forth between children as they played. Showed the holes of the harp on children's station monitors. We looked at and played in first and second parts on the harp. Use of a microphone seemed to be a lot of fun, and each child wanted and got a turn playing amplified harp over "All Talk."

<u>3-29-76</u>

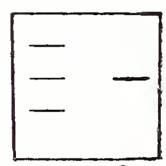
R did a math paper voluntarily on the ICTS. Wrote correct answers neatly in small boxes with no assistance lining up the paper.

Started use of pocket electronic calculator to check math work--introduced the calculator to whole afternoon math class via ICTS. We will put the calculator under a station camera, show resulting image on monitor screen, and let the children that can learn to do so check their math with the calculator via the ICTS.

Introduced D to calculator via ICTS. Today, she checked all of her multiplication and corrected her problems that needed correction. Started with C on multiplication.

<u>4-20-76</u>

Used 3 × 5 cards with words typed as follows:



One of the words in left column was the same as the one on the right. Had used this last week with older children successfully, but younger children had trouble moving paper to new area for circling next answer. Today I had children use a card for their first answer, circle the correct word on the paper at their stations, then just move the same circle to enclose the correct word on the image of subsequent cards. Younger children then tried it, assisted by the older ones, using the previously made circles. With no pencils and only one card to move on platform, nearly everyone was successful. I think this will work and can be adapted to other materials. This activity involves a teacher/student overlap.

5-4-76

Giving CTBS to T, if print was small enough to get more than three lines on screen, he couldn't read it. Test had an underlined word to match with four answers. He couldn't remember word long enough to move platform and read all four answers, so was spending much time going back and forth between word and possible answers. D and C had answered more than 20 questions before T got to No. 8.

5-13-76

As J often is not able to keep his papers right side up, we have color coded his X-Y Platform at the top with green tape, his monitor at the top with a green paper strip, and his paper with a green line at the top. Since we started this, J has been able to keep the orientation using the color clues.

5-26-76

Worked with B, my high school Braille student. He is able to fill out a svaings account deposit and withdrawal slip, write a check, and read the printout of a bank statement with the help of an ICTS station--and then read what he's written. A real boon to independence! (J-C)

6-11-76

E seems to see only the bottom part of his monitor well. He was taking a part of the Circus bottom, and seemed to be having difficulty following the images as he moved the platform. I walked to the console and made the top half of the screen dark. He covered his eyes as if something had gone wrong, but then seemed able to keep his Circus test on the bottom half of the screen only.

E quite easily marked his answers to the S.O.S. using the whole screen filled with the symbol, happy face and sad face. Even with margins set, he was unable to move down the column one number at a time.

TEACHERS' LOGS - KILLIAN

1976 - 1977

and

1977 - 1978

9-13-76

Whole Group Language Lesson

I went to the chalkboard (moved RC (Room Camera)) control to connection under chalkboard). We adjusted monitors using RC image of letters located above chalkboard. Good images on all monitor screens. I did most of the adjusting. Will place ICTS lesson for tomorrow on students' X-Y Platforms.

C handled master control buttons well as I told him which buttons to push.

As I scanned alphabet strip with room camera, I'd stop if a child's last name started with that letter. I had children spell their names as I printed them on chalkboard. Image contrast poor with best adjustment. However, E even saw images of letters well enough to identify a capital "O" as an "O." D took over RC control, and I was free to write on chalkboard and work with children. After all names were on the chalkboard, I used RC/and station overlay to permit the children to take turns circling "R's," H wrote the number of R's in each name on the chalkboard. A successful lesson, but next time I only want to work with half of the students at one time--too much waiting and looking; too little activity.

Older Group Language Lesson

Gave each of 6 children 1/2 of a word on a card. Used overlay of those two cards that had parts of same word to let the children "find-put" the whole word together. All liked this.

Used 4th Grade language book, Lesson 1, and a split image. One part of the lesson asked for the child to write words with letters in reverse order to form a new word. Most children were successful. What they wrote appeared on the bottom of their monitor screens. The reverse

of the word was displayed on the top half of their monitor screen and it came from the teacher's station.

Started filling in the blanks using overlay. This worked well, too. More of this tomorrow.

9-14-76

I really enjoyed the ICTS today. All planned lessons worked well and spontaneous use was also good.

Spontaneous use--K had some children lying on the floor to form a triangle as a guide for placing tape. Others went to stations and traced the "people triangle." Here I used overlay RC-self. Children loved it.

Math--J, E, and S. All other children using individual station on self-self so all stations were busy. The three boys stood in front of the master control unit while I projected, on the teacher's monitor, numerals being viewed by the teacher's camera. J said, after more than 5 minutes, "This is fun." I suspect his being able to stand up rather than sit was part of what he liked.

9-15-76

D helping at MC (Master Control unit). D had some difficulty with "the book," but operated MC quite well, even corrected an error I made.

Language-Visual Perception

Used visual closure cards by Milton Bradley. Had children complete glass and apple. Discussed a sound. After several apples were completed, I added a worm to each in a slightly different position using overlay. With rapid switching, worm wiggled. Children loved it.

9-16-76

Worked with large cut-out letters at the front of the room, using the room camera to teach date. Then moved on to show them how to abbreviate date. Each child told me what to write on the board and acted as a number or puctuation mark by standing in the place the number or punctuation mark should occupy in the date.

10-1-76

Whoops! Missed last week. *No* journal writing but *lots* of system usage. I'm really enjoying the system this year. I've continued using the system for a daily math lesson for the younger group. I try to spend one lesson each day (Math, Language, or Reading) emphasizing use of the system. Still working on locking and unlocking platform and focusing station camera. R is the only one who consistently tries to follow the suggested procedure, i.e., make image large, focus, then reduce image to desired size. He does quite well. Others can *sometimes* identify "focus ring" and "zoom ring." All children are becoming more aware of image quality.

10-4-76

M is now being consistently right-handed and working at a left-handed station regularly. I need to make a change. M, about once per day, drops a screw from the marginal stop control of his X-Y Platform. M was taking the Circus battery last week--doing so well I decided he needed to be tested on CTBS. Got same from warehouse and have started. He still has to be reminded to look at the monitor. Keeps putting his head between the camera and the X-Y Platform.

10-7-76

Tried something new today that worked! Children were getting restless, so instead of looking at their own monitor screens I had them go look to see what letter was missing on someone else's monitor screen. Instead of switching images, the children moved. The images were all the same on the monitors, because I was sending information from my station to all the student stations, but no one seemed to notice this in their enthusiasm to find out what was on the other screens.

10-13-76

I've used the system almost two hours daily this past week and am frustrated. We have worked only with zoom-focusing, and still all the little ones are unable to put a prepared piece of material under the zoom lens on the X-Y Platform and then focus the zoom lens without

individual attention. (R can sometimes do it--the *youngest* child in the room.) I believe I need to work with children individually and go over the zoom-focus.

10-21-76

Last Thursday and Friday the younger children did not use the ICTS at all. *No* child commented at all on Thursday. I was out of the room on Friday (at hospital with E). On Monday, R said to me in that sing-song nyah nyah pattern, "you weren't here so we didn't use the ICTS *Friday*."

I've been doing a lot of thinking about the ICTS and the little ones. I'm beginning to ask questions relating to the distance between teacher and child using the system. There are lots of factors involved which we have talked very little about. Relationship of focus of attention on teacher, content or concept being taught, and the system as a tool or part of the lesson. I'm trying to choose one lesson a day and focus *my* attention on system usage rather than the lesson content. It appears to me that all the older children are using the system as a tool for learning other material. If interest span is used as an indicator, little children all prefer stories read on the rug. Not one younger child has voluntarily gone to ICTS to read independently. I wonder if they would, if they couldn't see as well as they do. I want to observe M and E more when they are given a free choice to choose a book.

10-29-76

Made a tape of children in Halloween costumes. Played it back for them this afternoon as part of the Halloween Party. A good learning experience, I think, and lots of fun.

11-19-76

During a home visit I was asking questions about the ICTS. He repeated what he'd previously said about preferring to be on the shape (i.e., the geometric design on the room carpeting) to being on ICTS--but I questioned him further this time. He said he didn't like the

ICTS because he had to sit on a chair. (We've been concerned about chairs and have ordered new ones. I'll want to observe more about chair comfort when we get them.) I asked him if it were the case that his ICTS station was on the floor, would he like it better, and he quickly responded, "yes."

<u>11-24-76</u>

Playing lotto with younger group--displaying card on top half of a split image. Card at my station. Children at their stations match that card using their card. The images of their card appear in bottom half of their monitor screens. When Y found the correct match I said, "Look, Y has it. I'll let all of you see it," as I put the correct match on all monitors. J saw this match, and excitedly said, "I have it!" Even with an explanation he seemed to have difficulty accepting that Y had it, and not him.

<u>12-6-76</u>

Handwriting on ICTS: Cursive letters were introduced off system and on, then we made up practice sheets with the letters out of order but listed according to their form (i.e., P, R, B, or "if you can make a large "O" you can make a small "o"). Chalkboard was used in both cases, room camera and station/station when on system. Large letters were used with group close to chalkboard when off ICTS.

<u>12-8-76</u>

S had done some typing yesterday. This morning I displayed it at my station, and let the children at their stations take turns reading the letters S had typed. All seemed to enjoy reading when it was their turn to read. Very little listening to others reading took place. I wonder if the difference in the location of the sound source and the visual source has an effect on their (the children's) lack of focusing on listening to reading by a classmate?

After lunch I had R and S reading flash cards. They were taking turns and reading well. As M joined us I suggested we move to the

ICTS. I gave each child three cards and attempted to have each child in turn place a card on his/her X-Y Platform to produce an image on the monitor screens for all to read. The children seemed to be able to look at the image of the cards on the monitors, but couldn't leave their cards alone. Each time I'd switch to another station, I'd need to wait while the child at that station moved his/her card on his/her X-Y Platform until it appeared on the TV monitor screens.

1-5-77

J brought a Winnie-the-Pooh board game to school. I put the board on the floor and used the room camera to show the board on all stations. I think this would work well enough to be useful if all players have visual impairments bad enough to be able to see better with a closed circuit TV system than without one. M and E both watched quite intently. All others kept jumping up and going to the board itself to see it. The child whose turn it was to make a move had difficulty keeping from blocking with his/her body, the camera's view of the board. This game required color cues. I want to try this type of thing with a game more suitable to B and W.

2-4-77

One day this week E looked at his monitor and apparently recognized an out-of-focus image. He reached for the lens and turned the focus ring without any comment from me. I did adjust it further after he had attempted unsuccessfully to enlarge and fine-focus the image.

3-7-77

Have been working with cartooning the face (facial expression). It would seem at this point that in teaching the children to recognize facial expressions the most effective things to focus on are eyebrows and mouths. We have been working on the following expressions using cartoons and the children have been attempting to reproduce some of them via the room camera--Happy, Sad, Angry, Mean, Embarrassed, Suspicious.

3-17-77

Today I brought A to school with me. He is 7 and therefore the age level of my group. I found the comparison between his ability to handle ICTS and that of others, interesting. Tried a tic-tac-toe game between A and T. T was able to talk about polarity when A asked about his o's being white. T jumped up and ran to A's station and said, "turn this" (polarity switch). A's problems finding things on the screen by moving the platform showed me that my children, the yellow group, really have come a long way.

3-18-77

A game that is just at or slightly above the level of my yellow group in learning to operate the ICTS is playing our large animal lotto game. There are four animal cards--horse, pig, cow, and turkey, and smaller cards that display 1/6 of what each of the large animal cards shows. One student displays a small card on all monitors from his station. The child who has the whole animal, of which the displayed image is a part, matches (via overlay). Lots of platform movement and zoom usage needed. Children like it.

4-27-77

Because it's been so long since I've written in the log, I'm thinking about general comments. I wonder if the log would have had more value if I had written weekly the first year and daily this year. Little things that happen daily, somehow I'm not feeling are important enough to report. Example: Today J was reading in his reader, *Janet and Mark*. When he finished, I said, "Read these," pointing to a list of words in the back of the book. "I can't," he replied, "they're too small." When I sent him to his station he said he still couldn't. He made no attempt to enlarge the image of them on his monitor. When I gave explicit instructions to (1) namely, make them very large, (2) focus, now make them the size you want, he read all the words. Nothing comes automatically to J, but he's certainly willing to cooperate when given instructions.

T, both yesterday and today, worked with his head under the lens. T did tell me his set wasn't working this morning; he just hadn't removed the lens cap.

Another disconnected comment--if the ICTS were used exclusively with younger children, I think many of the difficulties I had earlier would not have occurred. I would keep the camera high and the lens caps off. I would have the sets on the floor and closer together.

Since some of my group can now work quite independently, I'm using the manual mode much of the time. I recall thinking last year, if I couldn't do it with all or self-modes or a combination thereof, it wasn't worth the time involved.* Just realized that now there isn't any appreciable time involved.

I tried putting typewritten words on cubes to use as flash cards. This will work. I didn't raise the camera so will need to experiment more with this. Takes lots of time to make such "cards." May decide time involved isn't worth it.

4-28-77

M took a flashcube to his station and looked and looked at it. We talked about reflections, light, etc. An excellent item for language discussion--a simple flashcube and the ICTS!

6-6-77

Each of the last three Wednesdays I have used the system for observing a live "science" object. The children were able to see the snake's eyes and fast-moving tongue. We actually traced a live mouse this last week. We all had fun, as the mouse was active.

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*An ICTS is in the "all" mode when the ALL buttons in the mode selector of the master control unit are depressed. In that mode every station monitor displays the same information.

An ICTS is in the "self" mode when the SELF buttons in the mode selector of the master control unit are depressed. In that mode each station monitor is displaying what its station camera is viewing.

9-21-77

The second lesson was a simple copying lesson. It could easily have been done with a magnifying aid BUT because of the system, it was a very interactive lesson. I started with the title displayed on the top half of all monitors and self on the bottom half. As some finished what was shown on their monitors, they began to encourage the slower ones to hurry so they could go on. As they went on copying--(J) repeated words allowed for different people being on different lines--rhyming words were pointed out. Lots of fun, lots of language--written and oral, and highly motivated slower students. A beautiful lesson on the ICTS.

I'm really enjoying having more stations than children. With the personnel I have it's easy to use the system for two groups of three. I can also have high school aides arrange letters on unoccupied X-Y Platforms, and then display them more quickly than from a single station.

9-28-77

Enjoyed using the room camera several times this week. I've put things on the chalkboard to copy. I've used both the chalkboard and the teacher's station. Some children are faster and I can have the room camera viewing one place, the teacher's camera viewing another.

Today's science lesson included looking at feathers. We looked at them using ICTS and a giant magnifier.

Because camera (5) is not working well, I keep having E move to (2). He does not stay at (2), he just moves back to (5). Being at "his own station" seems to be more important than having a high quality image. I'd like to switch cameras--(2) → (5) and (5) → (2).

11-7-77

At this point I would guess that orienting *young* children to the system would be much simpler were there no X-Y Platform at all. H and I have talked about my belief that the lack of friction control in the Y direction is a problem. Since both reading and writing are both so slow and laborious, the easy movement of the platform appears to me to be unnecessary and perhaps detrimental.

11-8-77

I suspect a place to keep a pencil could be added to a station at little cost and great convenience. How much time has been spent looking for pencils under X-Y Platforms and under the camera stand, I can't possibly estimate.

12-2-77

Now that the children I'm teaching are writing (printing), the system is much more valuable to me. To get samples of correct spelling and letter formation immediately via split screen to individual children is powerful. I had a group of spelling papers this week that were well above my expectations.

We are in a group reading session now using the split screen capability, when the upper half of the image on the students' monitor originates from the teacher's station and the lower half originates from each student's station. I can present one line of text at a time. The Ginn series 720 has all the student workbook pages reproduced in a smaller size in teacher text. I can give instructions beautifully with no adaptation.

12-12-77

At this point, working with the system suggests to me that the placing and arrangement of the system (floor plant) is more important than we had considered. In training teachers to use the system, it would seem to me that there should be an extended period in which the system is set up but not "installed." Perhaps several arrangements could/should be tried before finally installing all the stations. I believe at this point I could find other, more workable patterns.

1-11-78

Working with my group only today on facial expressions and discovered a way to get R to look slightly angry. I asked him to put his fingertips on a pencil and attempt to pull off the metal band that holds the eraser. When it didn't come off, he was to get angry because it wouldn't come off. Prior to this he always displayed a grin for angry.

4-10-78

I have thought for some time that the system develops residual vision. Some of the students seem to be able to "*see*" material off system that at one time they could not see. I have started to develop lessons in which I display material on the monitor at a student's station, then remove the image from the screen and ask a student to find a like *reduced* image on a paper. After the student *sees* the ICTS image, they are able (in many cases) to find and identify math problems, words, and other items which they could not locate and identify before exposure to the system image.

5-10-78

Finished CTBS testing today. E seems to locate the proper place to mark an answer easier than any other child. E is also the only child I did not observe looking directly at the test itself. J and S looked at the paper most of the time. R complained he couldn't see the paper; but when told to turn on his monitor, did so and continued to use the monitor most of the time. Although E's scores show much less progress than I believe he has made, there certainly was a difference in his handling of the materials and in his attitude. Even though so many of his answers were wrong, there was much more apparent thinking involved, i.e., he chose "siti" for city," "kak" for "cake," etc. Last year his choices appeared nearly random.

Earlier this week E said to me, "I can see it (pointing to monitor) on this side (pointing to right side of platform)." We had moved the monitor to the left for filming and it had not been moved back. I suspect this was E;s first voluntary request that his station configuration be changed for him! I thought this significant.

6-12-78

Well, the third year is ending. We have finished testing and it looks as if we have made our goals as far as testing is concerned. I also find that my thinking and feeling parts tell me "we have made it" in so many other ways. The children have learned to use their residual vision and I feel much "residual *insight*." What I mean is that the

system seems to have been a sort of door or entrance onto a new way of seeing the world. It has not been a passive carrier of what we put on it, but a part of learning to see in a new way.

We have taken the final photographs for the facial expression project, and it seems evident that my idea that expression was lacking and could be taught is correct. Today the children, of their own accord and without it being suggested, played both checkers and chess on the system. This use of the system as a tool is for me what we all have been working for. Over and over I see a child read, write, or do math, drawing and participating in many other activities on the system just because they can see better. It has been an outstanding experience in my life to work in the Randsight project these last three years.

Appendix B

COST ANALYSIS OF RANDSIGHT INTERACTIVE CLASSROOM SYSTEM

This is an attempt to establish a probable cost of an Interactive Classroom Television System (ICTS). The cost parameters used here do not necessarily apply to mass production conditions, but rather give some feel for the cost of an ICTS produced in small quantities, i.e., fewer than ten units per year.

A study was made by The Rand Corporation for The National Aeronautics and Space Agency (NASA) to develop cost estimating procedures for dealing with avionic equipment of various technologies. One of the technologies covered in this study was that of electronic controls and instrumentation. That technology included much of the technology used in the controller of the ICTS. The study indicated that average markup by the electronic manufacturers on products sold to the distributors was approximately five times the cost of the components used in the product. Further, the retail cost, cost to the consumers, averaged eight times the cost of the components. The markup will vary somewhat from product to product, the level of demand, and the quantity produced; even so the criteria used here will give some idea of the cost of an ICTS. The markup includes the cost of research and development required for the product as well as the time required to fabricate and check out the system.

The cost analysis presented below is based on design of the system using the technology that was available in 1975, the year when the second generation ICTS was built. The hardware design for future ICTSs should take advantage of all the new and sophisticated components and technologies that are available today. For example, microprocessor technologies are becoming cost effective for controllers such as that used in our second generation ICTS and should be seriously considered when designing future systems.

The cost of off-the-shelf equipment listed below reflects the full retail price. It is assumed that the manufacturer of the ICTS will purchase the required equipment on Original Equipment and Manufacturer (resale) basis and will pass that cost on to the purchaser as part of the full retail price.

ROOM CAMERA, MONITOR, VIDEOTAPE RECORDER

One unit per system			Unit Costs January 1979
1	Room Camera	GBC CTC6008	$ 865
1	Remote Zoom Lens	Pelco TV10C	1,550
1	Pan/Tilt Unit	Pelco PT155P	540
1	Pan/Tilt Zoom Controls	Pelco VR1500	330
1	Videotape Recorder	JVC Mod. 6300	2,140
1	17" Color Monitor	Sony Trinitron K1713	550
1	TV Sync Generator	Grass Valley Mod. 950H	1,050
		Total	$ 7,025

CONSOLE

The console used in the second generation ICTS was designed and fabricated by members of the staff of The Rand Corporation. A console is a video/audio switching system for switching the video/audio signals from one station to one or more other stations.* A console can present on any station TV monitor, independently of what it presents on any other monitor, a full screen image from any of the ICTS's TV cameras or from its videotape recorder, a horizontally split image from any two of those sources, and a superposition or overlay of full screen images--again from any of those sources.

Fixed Items	(minimum required)	Unit Cost		ICTS Cost
4	Power Supplies	@ $ 50.00		$ 200.00
1	Circuitboard Cage	@ 100.00		100.00
1	Cabinet	@ 200.00		200.00
18	Control Switches (min)	@ 7.00		126.00
			Total	$ 626.00

*A station consists of a television camera, a zoom lens with close-up capability, a television monitor, a light source and an X-Y platform.

STATION COSTS

A complete ICTS station consists of a large TV monitor (17 or 19 inch screen), a CCTV camera stand, an X-Y platform, a CCTV camera equipped with a zoom lens (4:1), and a light source. It can be purchased off-the-shelf for approximately $1800. However, we have found that the equipment sold as an individualized CCTV system lacks some of the features we consider to be essential for an ICTS station. These features or modifications are discussed below.

CCTV Cameras

Cameras used in an ICTS require an external synch capability. This follows from the fact that the video to and from all of the video sources of an ICTS must be in synch in order to successfully handle the presentation of overlay and split image displays.

X-Y Platforms

Most X-Y platforms, now produced by manufacturers of CCTV systems for the partially sighted, do not come with conveniently located friction controls in either the X- or Y- direction. Our users have found that the adjustable resistance to the platform movement provided by these friction controls is essential both for reading and for writing.

Monitor Stands

Our specially designed monitor stand permits the TV monitor to be placed closer to the TV camera stand than is possible with commercially produced monitor stands, and it does this without putting any constraints on the movement of the X-Y platform.

Termination Box

Unlike commercially available CCTV systems, each station of our ICTS is equipped with a box containing the electronic termination and the AC switch and distribution outlets required for that station. Multi-conductor

cable from the control cabinet carrying video, audio, and synch signals is terminated at this box and is distributed to the TV camera, the TV monitor, and the audio system of the station.

If all of the features discussed or referred to above are included in the initial manufacturing process, the additional cost should not exceed $800 per station. Hence total station cost should be about $2600.

Station Costs Summary

Production model CCTV Station	$1,800
Additional features for an ICTS	800
	$2,600

RETAIL COST OF 8 STATION ICTS

ROOM CAMERA, MONITOR, VIDEOTAPE RECORDER				$ 7,025.00
CONSOLE COSTS				
Fixed Items				626.00
Variable Items	No.	Unit Cost	8 Stations	
Station Switching PC boards	8@	$ 20.00	$ 160.00	
Int. Circuit Modules		40.00	320.00	
Logic PC boards	2@	20.00	40.00	
Int. Circuit Modules		160.00	320.00	
Video Synch Driver PC boards	1@	20.00	20.00	
Int. Circuit Modules		40.00	40.00	
Video Driver/Receiver PC boards	2@	20.00	40.00	
Int. Circuit Modules		40.00	80.00	
Audio Amp/Distrib. PC boards	2@	20.00	40.00	
Int. Circuit Modules		40.00	80.00	
Edgeboard Connectors	15@	10.00	150.00	
Cable Connector	24@	10.00	240.00	
Station Selector Switches	24@	7.00	168.00	
Cables	24@	5.00	120.00	
Misc. Elect. Components and Mechanical Parts			500.00	
TOTAL CONSOLE COMPONENT COST			$2,318.00	
TOTAL RETAIL COST (8 X COMP. COST)				$18,544.00
COST FOR STATIONS @ $2,600 8 units				20,800.00
TOTAL RETAIL COST				$46,995.00

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